CMFRI

वार्षिक प्रतिवेदन
Annual Report
2011-12

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
Post Box No. 1603, Ernakulam North P.O., Cochin - 682 018, Kerala, India

Central Marine Fisheries Research Institute

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भाकृ अनुप
ICAR

Annual Report
2011-12

केंद्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

कडलमीन™

cadalmin

Central Marine Fisheries Research Institute

(Indian Council of Agricultural Research)

Post Box No. 1603, Ernakulam North P.O., Cochin - 682 018, Kerala, India

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MANDATE

- To monitor the exploited and assess the under-exploited marine fisheries resources of the Exclusive Economic Zone (EEZ)
- To understand the fluctuations in abundance of marine fisheries resources in relation to change in the environment
- To develop suitable mariculture technologies for finfish, shellfish and other culturable organisms in open seas to supplement capture fishery production
- To act as a repository of information on marine fishery resources with a systematic database
- To conduct transfer of technology, post-graduate and specialised training, education and extension-education programmes
- To provide consultancy services

PREFACE

Scaling greater heights is indeed an achievement. But resisting gravity is more challenging. This we did through our untiring efforts in pursuit of a sustainable marine fisheries management framework and to supplement capture fish production with mariculutre output. Our efforts in this direction are presented thematically in this report.

A look at the international scenario indicates that except a handful of countries, all are depending on log book data supplied by the fishing units for estimation of marine fish landings. The marine fisheries of India, which is the second largest fishing nation in the world, is characterized by diversity in fishing units (from large mechanized units to catamarans) and involvement of a huge artisanal sector, necessitating and approbating the unique methodology we have developed for data collection. Ministry of Agriculture has recognized the CMFRI data as the official data of Government of India for use and to be supplied to FAO. This recognition is a reward for our committed research efforts in marine capture fisheries.

CMFRI successfully completed the pop-up tagging of yellow fin tuna (*Thunnus albacares*) for the very first time in Indian waters, with which India joins the elite group of countries engaged in satellite tracking of yellowfin tuna.

Breeding of high valued marine fish all over the world is highly challenging and only a handfull of countries have so far been successfull in breeding and seed produciton of marine food fish species. In this regard, it is heartening to note that in our quest to develop broodstock and seed production technology for various species, we have achieved success with Pompano (*Trachynotus blochii*) for the first time in India. The species tolerates wide salinity, grows fast and renders itself highly suitable for pond farming.

CMFRI came out with its second therapeutic molecule from the sea, the Cadalmin™ Green Algal Extract (GAe) in less than two years from the release of the first one GMe. This is a unique blend of 100% natural bio-active anti-inflammatory ingredient extracted from seaweeds with an eco-friendly "green" technology to combat joint pain and arthritic conditions. Commercialization of this will help the livelihoods of lakhs of fishers who depend on seaweed farming in India

The institute has gained wider visibility with the launching of eprints@cmfri done last year and this is expanding (with more than 10,000 articles uploaded) on and on with more rate of downloading of our publications daily. The accreditation of the Indian Journal of Fisheries published by CMFRI with an international impact factor of 0.04 is another feather in our cap. In addition to the above, all the capture fisheries divisions are continuing their effort to bring out practically implementable management advisories for sustainable marine fisheries management. The marine bio-diversity division continues its journey in developing the data base on corals and sponges on GIS platform. The fishery environment management division made rapid strides in restoration of mangrove habitats, which are the potential nursery grounds for many fish species. The division of socio-economics brought out the trade off between trade and development besides focusing on community participation on fisheries management. I wish to avail this opportunity to sincerely acknowledge the unstinted support received from the Director-General, ICAR and all my colleagues of CMFRI family.

01.08.2012
Kochi

G.Syda Rao
Director

EXECUTIVE SUMMARY

CMFRI has made imposing strides by pursuing channelized approach to its research endeavors during the year 2011-12. The research projects of the institute were attributable to 19 chosen themes encompassing the marine capture and culture fisheries domains.

The year 2011 witnessed an increase of 4.8 lakh tonnes as compared to the previous year and the provisional marine fish landings of India (sans the island areas of Andaman & Nicobar and Lakshadweep) was estimated as 3.84 million tonnes. The assemblage-wise contribution of fish resources saw the pelagic finfishes contributing to the tune of 56% alongside demersal finfishes, crustaceans and molluscs whose contributions were 26%, 14% and 4%, respectively. This year witnessed decline of motorised sector whose contribution was 19% of the total annual catch, the fall being 6% as compared to the preceding year. The mechanised and non-motorised artisanal sectors accounted for 79% and 2% respectively. Region-wise breakup indicated that the southwest region comprising the states of Kerala, Karnataka and Goa were the top contributors to the national figures with 31%, while the northwest region comprising Maharashtra, Gujarat and Daman & Diu was placed second with 27% contribution. The east coast accounted for 42% in all, a decline of 3% from the previous year. Amongst resources, oil sardine (*Sardinella longiceps*) topped the list with a contribution of 16.4% to the total marine fish landings of the country. Indian mackerel (*Rastralliger kanagurta*) was the second important resource after oil sardine with a share of 7.2%. The other important resources were penaeid prawns (7.1%), ribbon fishes (6.3%) and croakers (5.8%).

State-wise analysis of macro and micro information resulted in localised appraisals of the regional fisheries concerned. The total marine fish landings of Kerala was estimated to be 7.43 lakh tonnes with the major resources being oil sardine (43.3%), Indian mackerel (9.7%) and threadfin breams (9.0%). Among the resources focused upon, 19 resources including white baits, other sardines and squids recorded decline as compared to their previous year's figures. Special studies made in Lakshadweep indicated an alarming 40.3% decline in the catch rates of the traditionally practised pole and line fishery. Similarly the drift gillnet fishery also recorded a new low in the isles. Hooks and line fishery had a hike of 80% in catch rates as compared to 2010. The marine fish landing profile of Karnataka indicated that the record figures notched up in 2010 were being sustained. The total estimated landings was 3.9 lakh tonnes during 2011 with the constituent assemblages of pelagic and demersal finfishes authoring the hike. The catches of crustacea and molluscs declined during the year to the tune of 16.8% and 35.3 % respectively. The marine fish landings of Goa continued to record a declining trend with the total figures of 0.58 lakh tonnes which is a reduction by 34.6% over 2010 figures. Major resources plummeted during the course of 2011 were pelagics (35.1%) and demersals (39.0%). On the northern side of the west coast, Maharashtra recorded an estimated landings of 3.07 lakh tonnes, which was a 28% increase over previous year's figure. The pelagic resources dominated the breakup with 47% contribution with the crustaceans relegated to poor second position (23.7%) with demersal finfishes finishing very closely (23.3%). Among the pelagic stock, the signature species of the state viz. Bombayduck *(Harpodon neherius)*, got relegated to seventh position with previously lesser-known resources like oil sardine topping the list. Gujarat showed a considerable increase of 19.3% over 2010 figures with the 2011 landings tentatively hovering around 6.27 lakh tonnes. Almost all the resources recorded positive growth ratio except the molluscs.

As regards the east coast, the southeastern states of Tamil Nadu and Andhra Pradesh recorded increase over the corresponding previous year figures with the estimated landings of 6.04 lakh tonnes and 2.75 lakh tonnes respectively in 2011. The major resources of Tamil Nadu were clupeids (40.7%) and carangids (11.4%). Resources like cephalopods, shrimps and tuna have shown decline during the course of 2011. Andhra Pradesh marine landings were dominated by pelagic groups (58.3%), followed by demersal resources (26.6%), crustaceans (12.3%) and cephalopods (1.31%). During that period, the landing estimated of Puducherry were 6,550 tonnes. The northeast region, with West Bengal and Odisha as constituent states, contributed to the tune of 18% of the total marine landings of 2011.

On the fisheries impact front, it was found that the trawl operations led to an estimated landings of 1.21 lakh tonnes of low-value bycatch and discards, across the coast, monitored at Veraval, Mumbai, Karwar, Mangalore, Calicut, Cochin, Tuticorin, Mandapam, Chennai and Visakhapatnam. This quantity was valued at 97.2 crores and it formed a formidable 26% chunk of the total trawl catch.

During the course of investigations undertaken to study the country's oceanic and deepsea resources, a thriving fishing ground for deepsea aristeid shrimp *(Plesiopenaeus edwardsianus)* was located off Thiruvananthapuram in the west coast at about 900 m depth. Myctophids, which happen to be incidental bycatch, was recorded round the year indicating a plausible steady stream of supply. Among the various species, *Diaphus watasei*, has been found to have all indications to become a candidate species for exploitation. Studies on the various oceanic squid fishing methods indicated that the catch rates were higher in gillnets as compared to the jigging ventures. On the products side, a new range product from oceanic squid was developed and marketed under the brand name 'Arabian Sea Master Squid.'

Pop-up X-tags were deployed on yellowfin tuna *(Thunnus albacares)* for the very first time in Indian waters by the CMFRI during December 2011 to February 2012. Tagging was done in the Bay of Bengal Region from Visakhapatnam where eight tags were deployed and along the Arabian Sea tags were deployed off Lakshadweep Islands.

Characterization of genes for disease resistance in *Pinctada fucata* and *Crassostrea madrasensis* was carried out during 2011. Molecular genetic profiling of the two species from their natural habitats was also accomplished. Various combinations of feed material suitable for the candidate resources for cage culture viz. pompano and sea bass were designed to cater to their differing energy requirements.

A breakthrough nutraceutical product named Green Algal Extract (GAe) which contains immunostimulating and anti-inflammatory ingredients was developed in 2011. With its soul base in seaweeds, GAe is an import substitute with great market potential targeting the vast vegan population in India and abroad.

Investigations onto the status and impacts on marine habitats indicated that the traces of arsenic and mercury in selected finfishes and crustaceans, landed off various parts of Indian coast, were within the permissible limits. Similar results were recorded in the case of clams also. During the course of 2011, survey to estimate the extent of habitat loss suffered by the bivalve fishery and mangroves in Karnataka due to anthropogenic activities was conducted. The aftermath of oil slick triggered by a grounded cargo vessel off Mumbai coast was also assessed.

Studies on the impact of climatic factors on the fishery resources led to the creation of an extensive database on parameters like air temperature, wind speed, rainfall, sea water temperature, upwelling strength, chlorophyll etc. Seasonal and spatial patterns of resource abundance of valuable pelagic resources like tuna were recorded off Gujarat coast. Phenological changes, especially shifting of spawning season, were recorded in species like threadfin breams, oil sardine, Indian mackerel etc. Concerted efforts were made to collect, compile and document the Indigenous Technical Knowledge and tra-

ditional intellect of fishermen on climate change and marine fisheries and a compendium is on the anvil. Vulnerability of coastal districts of Tamil Nadu was studied and indices of relative gravity were developed. Mobile technology based transmittal of advisories on fishing grounds and wind status, christened m-KRISHI®, was put operational in the Raigad district of Maharashtra in partnership with TATA Consultancy Services.

On the mariculture front, many a stride were made during the year 2011 and the standout among them were accomplishment of broodstock development and seed production of cobia (*Rachycentron canadum*) and pompano (*Trachinotus blochii*) at Mandapam Regional Centre. Brood stock development of malabar red snapper and groupers have also made significant progress at different centres of the Institute.

An improved tweaking towards the sustainable seed production for farming the popular local delicacy species, pearl spot (*Etroplus suratensis*) has been accomplished in 2011. Farming trials of pompano and cobia in cages and ponds have been initiated and the results for the first season were quite encouraging. As important intervention towards popularizing cage culture amongst fishermen, affordable, low-cost GI cages have been designed, fabricated and tested in the Karwar Research Centre. Yet another major achievement on the culture front had been the in vitro pearl production from black lipped pearl oysters (*Pinctada margaritifera*) in Andaman. The success streak recorded in the previous years on the commercial seed production of clown fishes and damselfishes continued in 2011 also.

Under the research initiative taken towards studying the marine biodiversity off Indian waters, underwater surveys were conducted in two prominent stretches viz. Enayam to Kollam in the south and Saurashtra coast and Gulf of Kutch marine national park with special focus on status and health of coral reefs. Propagation studies on soft corals, *Sinularia* sp. and *Cladiella* sp., were conducted as a new initiative.

On the socio-economic front, the valuation of marine fish landings at the landing centre level (point of first sales) was estimated at Rs.24,372 crores and that of the retail centres (point of last sales) was found to be Rs.38,152 crores. The average fishermen share in the consumer's rupee was found to be 63.8%. The corresponding sales figures for 2010 were Rs. 19,753 crores and Rs. 28,511 crores, respectively. The Total Factor Productivity (TFP) analysis of Indian marine fisheries sector for the interregnum 2000-2010 was performed and the output index showed a positive growth of 3.4%.
Open access institutional repository, e-prints@CMFRI - The institute has gained wider visibility with the launching of eprints@cmfri done last year and this is expanding (with more than 10,000 articles uploaded) on and on with more rate of downloading of our publications daily.

CMFRI conducted 26 human resource development programmes in 2011 which were attended by 639 outside participants.

Krishi Vigyan Kendra (KVK), Njarakkal attached to CMFRI conducted 12 front line demonstrations during 2011-12. KVK commenced an animal breeding unit, green house and net house for raising vegetable seedlings and conducted soil health camps in five panchayats of Ernakulam district.

CMFRI bagged Indira Gandhi Rajbhasha Shield for the excellent Hindi implementation activities in 'C' region for the 2009-10.

The institute executed 30 in-house, 31 externally funded and 16 consultancy projects during 2011-12. Collateral attainments of these research endeavours were amply reflected by 128 research papers in peer reviewed journals, 39 technical articles, 61 popular articles and one book.

About CMFRI

CMFRI, Kochi

The Central Marine Fisheries Research Institute (CMFRI), one of the eight national fisheries institutes under ICAR, through its research and developmental activities in marine fisheries during the last five decades has been able to sustain the marine fish production through development and implementation of resource management strategies and policy advisories to the Govt. of India for fisheries governance. The Institute has been responsible for developing time series data base on marine fish production from the Exclusive Economic Zone (EEZ) of the country, their biology, distribution, abundance, fishery forecast, potential yield, stock assessment and in formulating management measures for sustainable production.

The significant/major achivements during 2011-12 from the Research/Regional centres are highlited.

▲ Head Quarters, Kochi

Mandapam Regional Centre

At Mandapam Regional Centre of CMFRI, a major breakthrough in Cobia and Silver Pompano (*T. blochii*) breeding and seed production was achieved. Successful broodstock maturation of Cobia was obtained in sea cages for the first time in India by feeding with suitable broodstock diets. Methods for induced breeding were also developed and successful spawning and larval production was achieved. The hatchery production of Cobia fingerlings can pave the way for large scale sea-cage farming of Cobia in our country.

▲ Mariculture Hatchery at Mandpam RC

Visakhapatnam Regional Centre

Nearly one lakh spat of *P. viridis* were produced in the marine hatchery at Regional Centre, Visakhapatnam. This is for the first time in India, where large scale spat production in the hatchery has been achieved.

▲ Mariculture Lab at Visakhapatnam RC


▲ Veraval Regional Centre


▲ Modular Biology Lab at Mumbai RC


▲ Karwar Research Centre


▲ Manglore Research Centre


▲ Calicut Research Centre


▲ Vizhinjam Research Centre


▲ Tuticorin Recearch Centre


▲ Kovalam Field Centre

Veraval Regional Centre

Veraval Regional Centre carried out grow-out demonstration of juvenile lobsters in open sea cages. This demonstration has proved the success of lobster farming in open sea, which will create an alternative livelihood opportunity for the coastal fisher folk in Gujarat. The Centre is also implementing a Tribal Sub Plan (TSP) for "Sidi" tribes of Gujarat.

Mumbai Research Centre

The centre operates the m-Krishi® Fisheries Service in 13 villages of Raigad District of Maharashtra under the NAIP Scheme on Strategies to enhance adaptive capacity to climate change in vulnerable regions.

Karwar Research Centre

Open sea floating cage demonstration farm for R&D in marine finfish and Shellfish production is established. The centre also developed a low cost Galvanized Iron (GI) cages for cage farming activities.

Mangalore Research Centre

The centre focusses studies on harnessing the positive effects of climate change in coastal areas. The centre has demonstrated viable technologies for the culture of species like red snapper, sea bass and seabream; molluscs like mussels and oysters in estuaries.

Calicut Research Centre

Studies on culture of *Etroplus suratensis* and red snappers are conducted.

Vizhinjam Research Centre

Survey and inventorying of bio-resources like corals and sponges are studied. Coral diversity and growth, fish assemblages and sponges associated with patchy coral reefs in South India are investigated using Line intercept transect and visual census methods.

Tuticorin Research Centre

The Centre carries out studies on technology development for seed production of clams *Paphia malabarica* and pearl oyster *Pinctada fucata*. Trained fisherwomen in implantation in marine pearl culture.

Chennai Research Centre

The new Marine Hatchery-cum-Research Complex at Kovalam Field Laboratory, was constructed. The centre carries out projects on installation of Artificial Reefs in the coastal waters of Tamil Nadu.

Fish Harvests

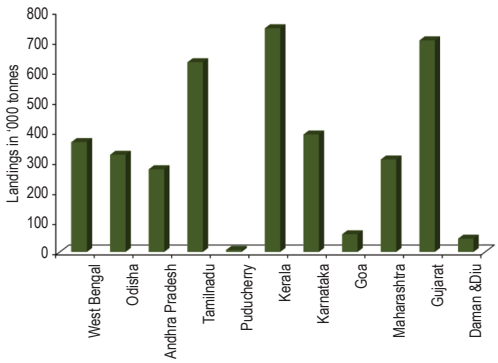
Information on marine fish landings and fishing effort were collected from different landing centres and fisheries harbours following the time-tested multistage stratified random sampling design. This involved planning and execution of the sample survey, co-ordination and monitoring of field work, development of computer software, processing of data, creation and updating of database, development of formats for data entry, storage, retrieval and development of database queries. Estimates of fishing zone-wise, resource-wise and gear-wise marine fish landings and effort expended were made for all the maritime states and also for all India. Individual species-wise estimates of landings for each state was carried out and added to the MS Access database for different months in 2011 using the software developed in-house.

- The marine fish landings of India during the year 2011 has, provisionally, been estimated as 3.83 million tonnes with an increase of about 4.8 lakh tonnes compared to the estimate for 2010.
- The pelagic finfishes constituted 56%, demersal fishes 26%, crustaceans 14% and molluscs 4% of the total landings.
- The sector-wise contributions during the year 2011 were; mechanised 79%, motorised 19% and artisanal 2%.
- The west coast accounted for 58% of the total landings and east coast 42%.

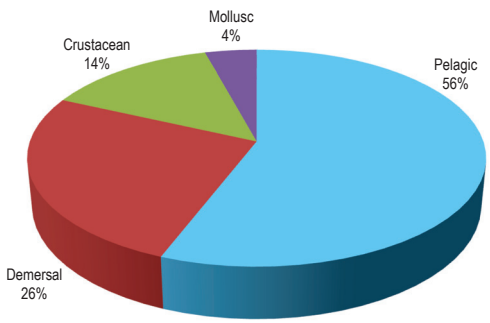
Region-wise and resource-wise estimates of marine fish production were made along with the effort expended by different types of gears. The estimate of region-wise production showed that the northeast region, comprising West Bengal and Odisha contributed 18% to the total production and the southeast region consisting of Andhra Pradesh, Tamil Nadu and Puducherry contributed 24%. On the west coast, the northwest region comprising Maharashtra and Gujarat recorded 27% of the total landings, and the southwest region comprising Kerala, Karnataka and Goa contributed 31%.

Contribution of major species/groups

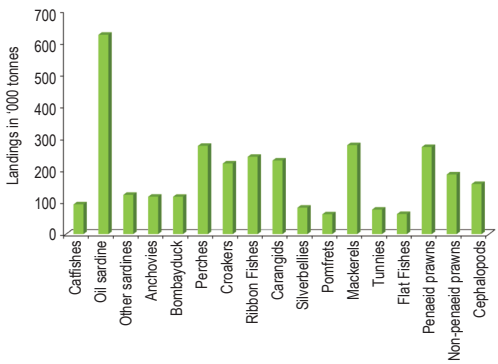
Oil sardine (*Sardinella longiceps*) remained the most important single species contributing 15.9% to the total marine fish landings in the country. The estimated landings of oil sardine for 2011 is 6,09,111 tonnes (t) against 4,88,205 t in 2010. The second important resource in terms of contribution towards total landings is Indian mackerel (*Rastrelliger kanagurta*) accounting



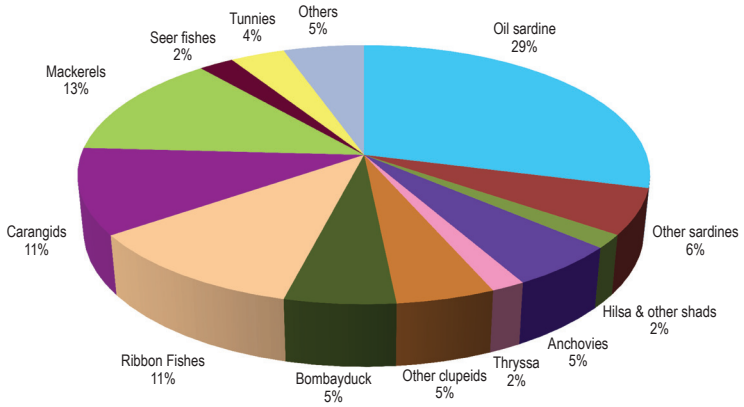
State-wise marine fish landings in India during 2011



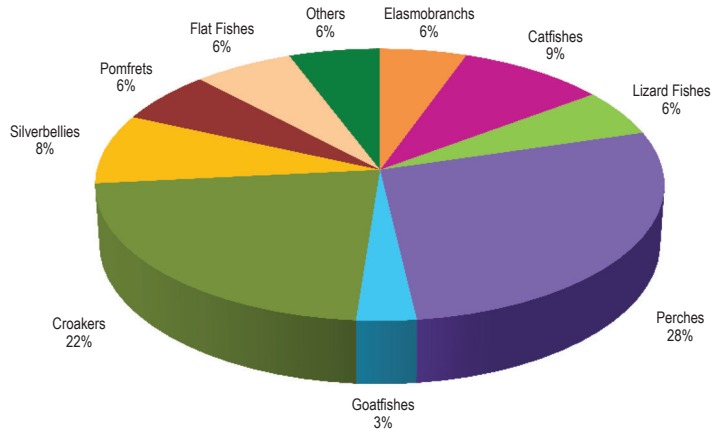
Components of marine fish landings in India during 2011



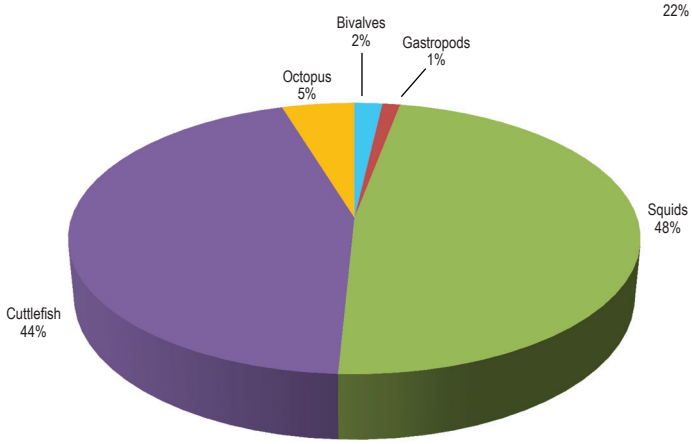
Landings of major fishery resources in India during 2011



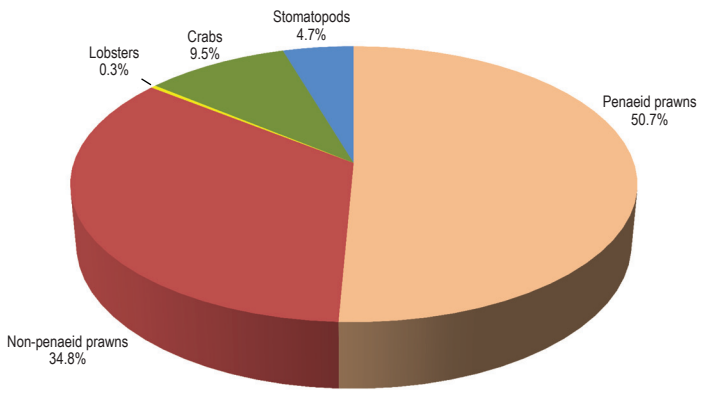
Pelagic finfishes



Demersal finfishes



Molluscs



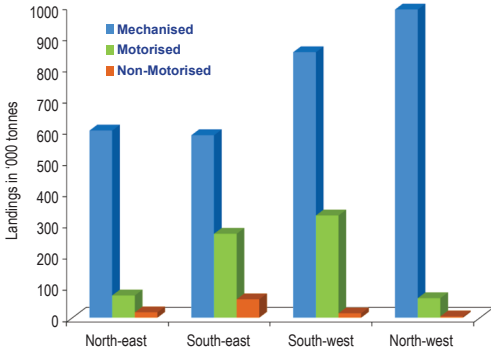
Crustaceans

Components of various groups in the marine fish landings of India during 2011

Estimated marine fish landings (t) during 2010 and 2011*

Pelagic finfish			Demersal finfish		
Name of fish	**2010**	**2011**	**Name of fish**	**2010**	**2011**
Clupeoids			Elasmobranchs		
Wolf herring	20365	23552	Sharks	25425	28013
Oil sardine	488205	609111	Skates	1958	2706
Other sardines	90846	122935	Rays	18184	24017
Hilsa shad	84267	21901	Elasmobranchs Total	45567	54736
Other shads	7644	14582	Eels	11222	10548
Coilia	31994	37329	Catfishes	85675	93189
Setipinna	12292	15239	Lizardfishes	57917	55800
Stolephorus	81008	64603	Perches		
Thryssa	39281	36098	Rock cods	24344	26006
Other clupeids	75093	80641	Snappers	7651	7286
Clupeoids Total	930995	1025991	Pigface breams	7679	15546
Bombayduck	108415	116901	Threadfin breams	129539	174079
Half beaks & Full beaks	3971	5474	Other perches	46184	53606
Flyingfishes	431	1239	Perches Total	215397	276523
Ribbonfishes	170843	242563	Goatfishes	33226	30543
Carangids			Threadfins	8237	9463
Horse mackerel	32122	37116	Croakers	192802	221592
Scads	43997	104903	Silverbellies	75571	82806
Leather-jackets	11638	12311	Whitefish	11856	9686
Other carangids	79670	76323	Pomfrets		
Carangids Total	167427	230653	Black pomfret	20391	20545
Mackerels			Silver pomfret	27398	36205
Indian mackerel	267250	278495	Chinese pomfret	5158	5420
Other mackerels	3	8	Pomfrets Total	52947	62170
Seerfishes			Flatfishes		
S. commersoni	26625	31363	Halibut	1109	1154
S. guttatus	15225	17535	Flounders	194	217
S. lineolatus	16	10	Soles	45527	61454
Acanthocybium spp.	117	46	Flatfishes Total	46830	62825
Seerfishes Total	41983	48954	Miscellaneous	25846	27416
Tunnies			**Demersals Total**	**863093**	**997297**
T. albacares	7703	9347	**Shellfish**		
E. affinis	21289	32937	Crustaceans		
Auxis spp.	11236	12494	Penaeid prawns	260182	272969
K. pelamis	4901	8758	Non-penaeid prawns	126997	187057
T. tonggol	5590	11116	Lobsters	1715	1852
Other tunnies	2604	1963	Crabs	52238	51305
Tunnies Total	53323	76615	Stomatopods	30149	25250
Billfishes	8489	10046	**Crustaceans Total**	**471281**	**538163**
Barracudas	24692	25602	Molluscs		
Mullets	5775	11804	Cephalopods		
Unicorn cod	341	422	Squids	93753	77267
Miscellaneous	55070	58628	Cuttle fishes	73812	71922
Pelagics Total	**1839008**	**2132675**	Octopus	4014	7661
			Miscellaneous	1697	5277
			Molluscs Total	**173276**	**162127**
			Shellfish Total	**644557**	**700290**
			Grand Total	**3346658**	**3830262**

* Provisional estimate



Sector-wise landings in different regions during 2011

for 7.27% of total landings, the estimate for 2011 being 2,78,495 t compared to 2,67,250 t in 2010. The estimated landings of other important resources are penaeid prawns 2,72,969 t (7.1%), ribbonfishes 2,42,563 t (6.3%), croakers 2,21,592 t (5.8%), non-penaeid prawns 1,87,057 t (4.9%), threadfin breams 1,74,079 t (4.5%), cephalopods 1,56,850 t (4.1%), lesser sardines 1,22,935 t (3.2%) and Bombayduck 1,16,901 t (3.1%).

Catfish fishery of Southwest coast- a silver lining on the horizon?

Marine catfishes have steadily been occupying the status of an established fishery since long in India. Albeit maintaining an annual contribution of around 50,000 t, the geo-spatial pattern of landings has changed significantly of late. From the earlier hotspots in the southwest coast comprising Kerala, Karnataka and Goa, the group is now being landed more from newer waters like those off Gujarat, West Bengal and Odisha. The southwest coast had witnessed a complete wiping out of this group in the interregnum of 1992- 2007, but during the past four years, there are clear signs of its recovery. Although the landings reported from Kerala have not made substantial recovery, Karnataka and Goa have recorded steady strides of resurrection of the fishery with figures of 2,300 t and 2158 t. respectively in 2011 .

Oil Sardine hits an all time high

Oil Sardine, a regional fishery in nineties, has recorded a spectacular surge in the past quinquennium and it has topped the 6 lakh t mark this year. Maharashtra has recorded the highest growth rate and oil sardine fishery has climbed up the rungs to be bracketed with top contributors. The inroads made by this fishery in Tamil Nadu in the last couple of years are being sustained this year too. Kerala has been reporting steady increase in the landings of oil sardine whereas its neighbouring state Goa has sustained after a major fall in 2009.

Highlights from the regions

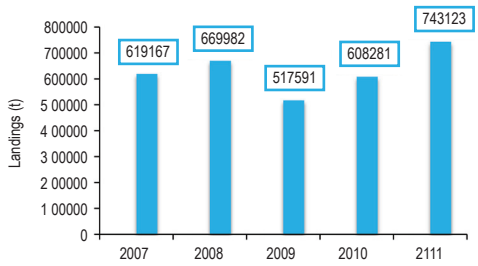
- During 2011-'12 Karnataka witnessed the operationalisation of two new mechanised fish landing centres at Shirali Alive Kodi and Mudge - Amadalli, both in Uttara Kannada, with 35 and 80 mechanised units in action respectively.
- Goa has witnessed retardation in fishing activities probably due to palpable decline in labour force. The probable reason could be that the fisherfolk find other sectors like tourism, more lucrative.
- Tamil Nadu has reported unprecedented landings of scads (*Decapterus russelli*) in 2011-12 in Kanyakumari district.
- Karaikal fisheries harbour has started functioning in the current year with an average utilisation by 80 mechanised units per day.
- In Maharashtra, oil sardine fishery has once again emerged as major contributor in 2011 after 2007. Most of the oil sardines were landed by purse seiners operating from Ratnagiri and Raigad districts.

Sustainable Management of Fishery Resources

Kerala and Lakshadweep

Kerala

The total marine fish landings along the Kerala coast was 7.43 lakh t during 2011, which was 22.2% more than that (6.04 t) of 2010. The overall increase recorded was mainly due to the increased production of oil sardine (+62760 t), threadfin breams (+33185 t) and ribbonfishes (+17514 t). Pelagic finfishes constituted 73%, demersal finfishes 16%, crustaceans 6% and molluscs 5% of the total landings. The contributions of mechanised, motorised and non-mechanised sectors were 62%, 37% and 1% respectively. The total unit efforts (19.5 lakh) operated increased by 18.5% in 2011 compared to that of 2010. While the total effort in fishing hours (104.3 lakhs) expended increased by 19.7% in 2011, the average catch per hour realised has increased only by 2%.



Total marine fish landings of Kerala during 2007-2011

Yield of 40 out of 59 important groups monitored has registered increase, whereas 19 groups declined in their landings during 2011. The groups which recorded significant increase were skates (+140.1%), catfishes (+321.4%), pigface breams (+181.1%),leather jackets (+302.9%), white sardines (+236.9%), silver pomfrets (+200%), Chinese pomfrets (+189.3%), longtail tuna (+113.8%), non-penaeid prawns (+187.5%) and lobsters (+109.8%). Important resources which registered significant decline were white baits (-17039 t), other sardines (-1563 t), squids (-2036 t) and stomatopods (-2613 t).

The major groups which contributed to the fishery during 2011 were oil sardine (43.3%), Indian mackerel (9.7%), threadfin breams (9.0%), carangids (5.8%), penaeid prawns (4.7%), cephalopods (4.6%), ribbonfishes (3.7%), *Stolephorus* sp. (3.5%), tunas (2.3%), soles (1.9%), lizardfishes (1.5%), seerfishes (0.9%) , non-penaeid prawns (0.8 %) and other sardines (0.6%). The major gears that supported the fishery were seine nets (57), trawl nets (30.3%), gillnets (7.6%) and hooks and lines (3.3%).

Indian mackerel landed at Kochi

Fourth quarter with a contribution of 27.6% was the most productive period, followed by the third quarter (26.1%), second quarter (23.7%) and first quarter (22.6%). The highest (87979.8 t) landing was recorded during the post monsoon/post ban period of August and the least (45887.6 t) was in March. District-wise production showed that Ernakulam with 19.6% landings ranked first followed by Calicut (18.8%), Malappuram (14.8%), Kollam (12.2%), Trichur (9.7%), Kannur (7.6%), Alleppey (7.4%), Trivandrum (7.2%) and Kasaragod (2.8%).

The catfish fishery, which was almost collapsed, seems to be on the revival path with 321.4% increase over 2010. White sardine, *Escuolosa thoracata,* fishery with 236.9% increase (1184.9 t to 3992.5 t) during 2011 also seems to be on the revival path. Belonids need closer attention/study as a high value emerging resource.

Pelagic resources

The pelagic resources constituted 73% (5,42,480 t) of the total Kerala landings, which was 25.6% more compared to 2010. The major contributors were oil sardines (59.4%), Indian mackerel (13.3%), carangids (8.0%), ribbonfishes (5.0%), white baits (4.8%), tunas (3.2%), seerfishes (1.2%) and other sardines (0.8%).

Length (cm) based biological indicators of major pelagic resources of Kerala

Species	L_r	Mean	Mode	L_{mat}	L_{opt}	L_c	L_{max}
Alepes djedaba	10.1	17.7	16, 22	13.7	13.8	15.7**	22.60
Selar crumenophthalmus	14	20.6	22, 24	16.7	17.0	18.2**	27.6
Megalaspis cordyla	14	28.6	22, 26	25.0	26.0	23.6**	40.2
Trichiurus lepturus	22.5	64.3	61.2	47.3	50.9	43.9**	114.4
Scomberomorus commerson	17	63.4	54.68	70.1	77.1	74.4* (31.3)**	149.0
Acanthocybium solandri	64	82.2	72, 88			72.2*	128.0
Euthynnus affinis	38	47.8	44, 52	37.7	40.1	40,6*	72.0
Auxis thazard	22	36.2	36, 44	27.5	28.8	29,7*	50.0
Auxis rochei	19	26.2	26, 30	23.6	24.5	24.9*	38.0
Rachycentron canadum	24		57,89	54.0	77.0	54.0*	160.0
Rastrelliger kanagurta	8.5	16.9	16.0	17.0	17.5	17.0***	27.1
Sardinella longiceps	4.0	13.5	13.9	16.5	14.1	15.1***	21.5
Encrasicholina devisi	7.0	8.5	8.7	6.2	6.3	7.9***	10.5
Stolephorus commersonii	7.5	10.1	10.4	7.3	7.4	8.5***	15.5

* *Hooks & line/Gillnet,* ** *Trawl* *** *Ring-seine*

White sardines landed by gillnet units

Oil sardine: The oil sardine, *Sardinella longiceps* with 43.3% (3,22,103 t) contribution was the most important resource in Kerala landings which formed 59.4% of the pelagic landings. Oil sardine landings during the year recorded an increase of 24.2%. The tremendous increase recorded during the year was due to the heavy exploitation of juveniles and young ones of size <160 mm, which formed >78.5% (in numbers) by seine net units. The peak landings were recorded in November-December and January. Seine net units with a production rate of 1,240.3 kg unit^{-1} was the most efficient gear which contributed 97.9% of the sardine landings. Gillnets and trawlers contributed 1.5% (16.5 kg unit^{-1}) and 0.7% (13.3 kg unit^{-1}) respectively. Although, the exploited size ranged from 40-215 mm in TL, the fishery dominant group was 109-130 mm in seine net units, 135 - 155 mm in trawls and 170 - 184 mm in gillnets. The mean size of the species was small but the length at capture (L_c) was larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). This indicates that the exploitation of stock is at biologically safer level. Profuse spawning and the initial fast growth with short life span help the stock to maintain the balance as long as the environmental factors are not adverse.

Indian mackerel: The Indian mackerel, *Rastrelliger kanagurta* with 9.7% (72,067 t) landings recorded an increase of 5.2% over 2010. Immature fishes (<170 mm) contributed 58.4% (in numbers) of the landing. The maximum landings were observed during May-August. The seine net units with a production

Estimates of exploitation and mortality rates of major pelagic resources in Kerala

Species	Exploitation rate (E)	Fishing mortality (F)	Total mortality (Z)	Natural mortality (M)	Remarks
S. crumenophthalmus	0.502	1.69	3.36	1.67	Optimally exploited
A. djedaba	0.487	1.29	2.65	1.61	Underexploited
M. cordyla	0.559	2.64	4.00	1.36	Overexploited
T. lepturus	0.484	1.24	2.22	0.98	Underexploited
E. affinis	0.717	3.27	4.56	1.29	Overexploited
A. thazard	0.481	1.52	3.16	1.64	Underexploited
A. rochei	0.566	1.58	2.79	1.21	Overexploited
S. commerson	0.697	5.32	7.63	2.31	Overexploited

rate of 190.6 kg unit^{-1} contributed 68.3% and the trawls 23.6% (@ 48.2 kg unit^{-1}) and gillnets 8.1% (@ 13.3 kg unit^{-1}) to the mackerel landings. The exploited sizes ranged from 68 - 271 mm in TL, with 130-205 mm as the fishery dominant group. The peak spawning was during the months of April-May and October-November. The mean size of the species is larger than the size at maturity (L_{mat}) and same as optimum size for exploitation (L_{opt}). But L_c was slightly lower than the L_{opt}, necessitating a cautious approach.

Bumper catch of oil sardine

Carangids: Carangids contributed 5.8% to the total marine fish landings of Kerala. It increased by 29.8%, from 33,218 t in 2010 to 43,103 t in 2011. Several gears exploit the resource, with large species by hooks and line as well as drift gillnets and small species by trawl, purse seines, ring seines and non-mechanised gears. Fishery was supported by 37 species, with 8 at commercial level. Scads constituted 61.9% of the total carangids with the dominance of *Decapterus* sp. contributing 43% of the catch. Except the landings of horse mackerel and black pomfret, all species registered increase. Young ones of all species were encountered in the catch round the year, with peak during southwest monsoon period. Mean size and length at capture (L_c) are larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}) for *Alepes djedaba*, *Selar crumenophthalmus* and *Megalaspis cordyla*. Stock assessment showed that the small carangids remain under-exploited or at near optimum level and had marginal scope for improved production. *M. cordyla* was exploited slightly above the optimum level and needs caution in increasing fishing pressure over the resource. In the case of small carangids, the stock is in good health, but needs caution and appropriate strategies to maintain the stock level and to enhance yield from present grounds.

Carangids landed at Kochi

Ribbonfishes: Ribbonfish landings increased by 181% over the previous year from 9,676 t to 27,190 t. Fishery was irregular with 98% contribution during September – November along Kerala. The maximum catch was recorded during October. Three species, dominated by *Trichiurus lepturus*, supported the fishery. *T. auriga* and *Eupleurogrammus* spp. were also encountered in the deepsea trawl landings occasionally. Trawls (82.5%), gillnets (14%), hooks and lines (3.5%) and ring nets (0.1%) were the gears employed in their exploitation. Mean size in the catch is larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}); whereas length at recruitment (L_r) and length at capture (L_c) are much smaller. Stock assessment shows that the resource is lightly overexploited and had no scope for improved production from the present grounds. Possibilities for improving production by hooks and line from deeper waters need to be explored.

Heavy landings of Ribbonfish, Calicut

Ring net catch of anchovies at Puthiyappa (Calicut)

Whitebaits: The whitebaits contributed only 3.5% (2596.2 t) to the Kerala landings. The landing declined by 39.6% in 2011. February was the most productive month. Seine net units @45.5 kg unit^{-1} contributed 71.1% followed by trawls @14.8 kg unit^{-1} (27.9%) and rest (1%) by gillnets and non-mechanised gears. Five species were observed at commercial level with the dominance of *Encrasicholina devisi* (70-110 mm TL) with 36% at north Kerala /Malabar region and *S. commersonii* (80-155 mm TL) with 50% dominated in central Kerala. Other important species were *S. waitei* - 15.4%, *S. insularis* - 9% and *S. indicus* - 7.0%. *S. punctifer* and *S. heterolobus* were also landed in small quantity in Malabar. The mean size and the length at capture (L_c) of dominant species; *E. devisi* and *S. commersoni* are larger than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). This indicates that the exploitation of stock is at biologically safer level.

Seerfishes: Seerfish landings registered an upward trend with 83.3% increase from 3,536 t in 2010 to 6,490 t in 2011. Major share (54.7%) was contributed by hooks and line, followed by gillnets (28.6 %) and the rest (16.7 %) by ring seine and trawls. The fishery, dominated by *Scomberomores commerson* (97.5%) was supported by three species. *S. guttatus* (2.3%) and *Acanthocybium solandri* (0.2%) also contributed in small quantities. Landings of *A. solandri* showed a sharp decline (-75.6%) in 2011. Landings of *S. commerson* was supported by small fishes (17-30 cm) in trawl and ring seines almost round the year, with peak during June to September. Mean size, length at recruitment (L_r) and length at capture (L_c) are much smaller than the size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). Stock assessment shows that *S. commerson* is overexploited. Enforcing minimum legal size close to L_{opt} for harvest and marketing will help in improving the stock as well as production.

Yellowfin tuna landed at Kochi

Tunas: Tuna landings, after continuous decline since 2008, registered an upward trend by 31.9%, from 13170 t in 2010 to 17374 t in 2011. They were landed mainly by drift gillnets as well as hooks and line and to some extend by ring seines. Fishery occurred round the year with peak during April and September-November. However, small coastal tunas landed round the year with peak during June to September. Fishery was supported by eight species, six at commercial level. Coastal and neritic tunas together constituted 87.1% of the tuna catch and was dominated by *Euthynnus affinis*, which represented 49.2% of the total tuna catch. Catch of coastal/neritic tuna improved considerably, whereas that of oceanic tunas continued their decline. Oceanic tuna fishery was supported by *Thunnus albacares* (8.6%), *Katsuwonus pelamis* (4.1%) and the rest by *Gymnosarda unicolor*.

Fecundity (per kg body weight) of *E. affinis* was estimated to vary between 90,876 and 112,432, *Auxis thazard* between 98,463 and 128,432 and *A. rochei* 265,342 and 39,167 eggs. The length at capture (L_c) and mean size of coastal tunas are almost equal or larger than size at maturity (L_{mat}) and optimum size for exploitation (L_{opt}). Stock assessment of coastal tunas showed that *E. affinis* and *A. rochei* were exploited slightly above the optimum level and *A. thazard* close to optimum level. This necessitates caution, to maintain the stock and fishery at the present level or slightly below it. On the other hand, scope for increased production from less exploited area like sea ridges, mounts and knolls needs to be explored.

Juveniles of seerfish landed at Beypore

Billfishes: The fishery was supported by *Istiophorus platypterus*, *Makaira indica* and *Xiphias* spp. Production improved marginally by 8.3% from 2,339 t in 2010 to 2,534 t in 2011. Fishery occurred round the year with peak during April and October-November. Juveniles, measuring 11 cm in TL, encountered in considerable numbers in January from Lakshadweep waters indicates the spawning period as November/December

Cobia: An estimated 685 t of cobia (*Rachycentron canadum*) was landed by hooks and line, gillnets and trawls. Catch registered an increase of 32.2% in 2011. Catch was supported by 24 -160 cm population with modal size of 54 - 58 cm in trawl and 88 – 100 cm in hooks and lines and gillnets. Growth parameters estimated were L_{∞} = 184 cm, K = 2.6 (year $^{-1}$). Length at capture (L_c) is small compared to L_{mat} and L_{opt} indicating stress on the stock. Stock assessment also shows that species is overexploited, necessitating cautious approach in the exploitation of the resource.

Threadfin bream landings at Kochi

Demersal resources

The total demersal fish landings (1,18,900 t) increased by 30.3% compared to 2010. Demersal groups formed 16% of Kerala landings. The major contributors were threadfin breams (55.9%), flatfishes (11.8%), lizardfishes (9.5%), other perches (6.3%), croakers (4.9%), elasmobranchs (3.2%), groupers (2.4%), bull's eye (2.3%) and snappers (1.1%). Almost all demersal resources except bull's eyes and snappers exhibited an increase in production.

Threadfin breams: Catch during the year was 66513 t, which exhibited upward trend with 99.6% increase. They contributed 9% to the total Kerala landings and 55.9% of the demersal landings. Bulk of the catch (98%) were landed by trawlers and the rest by gillnets and hooks and lines. Catch rate recorded in 2011 in multi-day trawlers was 17.2 kg h^{-1} against 8.1 kg h^{-1} in 2010, with the highest of 122.2 kg h^{-1} in August. *Nemipeterus randalli* (58%) dominated the fishery followed by *N. japonicus* - 40.5% and *N. tolu* (=*peronii*) -1.5% in Malabar. However, the species and percentage contribution in central Kerala was *N. randalli* (61%), *N. japonicus* (31%) and *N. bipunctatus* (8%). Juveniles and immature fishes formed 82.6% of *N. japonicus* landed and that of *N. randalli* was 74.5% in Malabar. Spawning stock biomass of *N. randalli* and *N. japonicus* in Malabar were >30% of the stock at its unexploited level, which indicates the regeneration capacity of the resources.

Cynoglossus spp. landed at Calicut

Flatfishes: Flatfish catch during the year (14043 t) increased by 12.6% over 2010 and formed 11.8% of the demersal landings. Bulk of the catch (99.1%) was landed by trawls and the rest (0.9%) by non-mechanised units. *Cynoglossus macrostomus* (42-177 mmTL) was the dominant species at Malabar (80.9%) and central Kerala (73.5%). Other species were *C. dubius* (9.2%)

Fishery related parameters of major demersal finfish resources of Kerala

Species	Length range (mm)	Mean size (mm)	Fishery dominant size group (mm)	E	SSB (t)	St. SB (t)	Fecundity	L_{opt} (mm)	L_m (mm)	Yield (t)	T_{max} (y^{-1})	L_{max} (mm)	L_r (mm)
C. limbatus	824-2324	1395.0	1200-1800	0.78	34	65	-	2190	1400	63	-	2324	476
N. randalli	24-234	129.1	80-140	0.68	2094	4227	12548-52158	188	128	13956	3.2	248	24
N. japonicas	44-304	136.8	125-180	0.67	2627	3923	20154-68754	211	134	10087	3.37	304	44
C. macrostomus	32-177	102	80-130	0.52	2840	5589	24251-55214	117	102	6744	3.27	177	32
J. sina	44-274	136.2	120-170	0.78	2345	4067	22154 - 54281	155	122	1628	6.7	232	44
O. ruber	74-344	173.2	140-220	0.73	71	99	85154-156871	286	158	224	5.5	348	74

E- Exploitation rate; SSB- Spawning stock biomass; St. SB- Standing stock biomass

Saurida tumbil landed at Puthiyappa (Calicut).

Barracuda (*S. obtusata*) landed at Beypore

Groupers landed at Kochi

C. arel (6.8%) and *C. bilineatus* (2.3%) in Malabar region. *Synaptura* spp., *Zebrias synapturoides, Pseudorhombus arsius etc*., were also occasionally landed at central Kerala. Juveniles (23.4%), immature and maturing (28.2%) fishes supported the fishery of *C. macrostomus* in Malabar. Virtual population analysis carried out on *C. macrostomus* shows that the spawning stock biomass estimated is more than 35% of the annual stock at its unexploited level.

Lizardfishes: Catch during the year (11,292 t) increased by 47.6% compared to 2010 and formed 9.5% of the demersal landings. Major share of the catch (90.7%) was landed by multiday trawlers followed by single day trawlers (1.8%), outboard seine nets (1.7%), outboard gillnetters (0.3%) and the rest (5.5%) by others. *Saurida tumbil* (53.6%), *S. undosquamis* (38%), *Trachynocephalus myops* (4.4%) and *Synodus englemani* (4%) were the species which supported the fishery. *S. tumbil* ranged from 205 - 475 mm TL with 330 mm mean size and that of *S. undosquamis* was 105 - 345 mm and 213 mm respectively.

Sciaenids: Catch during the year (5786 t) increased by 41.7% over 2010 which formed 4.9% of the demersal landings. About 41% of the catch was contributed by trawlers followed by seine nets (36.9 %), gillnets (7.7 %), and the rest (13.3%) by others. The fishery was supported by 11 species belonging to four genera. *Johnieops sina* (63.2%) was the dominant species followed by *Otolithes ruber* (12.2%), *O. cuvieri* (5.9%), *Johnius caruta* (4.9%), *J. macropterus* (4.2%), *Nibia soldado* (2.2%), *J. belangerii* (1.8%), *J. glaucus* (1.8%), *N. maculata* (1.4%), *J. aneus* (1.4%) and *J. vogleri* (1.0%). Although the sciaenid resources especially *J. sina* and *O. ruber* were heavily exploited, the spawning stock biomass estimated for both the species were more than 35% of the resource at its unexploited level which is a good indicator showing its capacity to revive the fishery.

Barracudas: The barracuda landings (3510 t) increased by 9.6% compared to that of 2010 which formed 3.2% of the demersal landings. Catch was contributed by trawl nets (48.9%), gillnets (15.5%), hooks and lines (8.9%), seine nets (6.8%) and the rest (19.9%) by others. The fishery was supported by four species, of which, *Sphyraena obtusata* dominated with a share of 65% followed by *S. forstieri* (23%), *S. jello* (9%) and *S. barracuda* (3%). The size of *S. obtusata* varied from 185 - 315 mm with the mean length of 246 mm. Mature eggs were observed throughout the year with two peak spawning in January-April and October- December.

Groupers: The grouper catches during the year (2875 t) increased by 7.2% compared to 2010. They formed 2.4% of the demersal landings and were landed by gillnets (38.3%), trawlers (34.6 %), hooks and lines (15%) and others (12.1%). *Epinephilus diacanthus* (juveniles and immature fishes, 100 - 340 mm TL) was the single major species in the trawl landings and the same formed 42.8% in the hooks and line landings. Other important species were *E. epistictus*, (24.8%), *E. chlorostigma* (12.2%), *E. longispinis* (8.4%), *Cephalopholis sonnerati* (2.1%), *E. flavocaeruleus* (1.4%), *Variola louti* (0.8%), *C. urodeta* (0.6%), *E. bleekeri* (0.6%) and *E. areolatus* (0.6%). *E. diacanthus* is a continuous spawner and spawning take place within 100 m depth zone. The fecundity varied from 3,18,217 to 10,82,752 nos. The size of *E. longispinis* in hooks and line fishery varied from 240-490 mm TL. The species is a continuous spawner and all size groups were encountered in the landings throughout the year. The fecundity varied from 1,10,106 to 6,05,811 numbers.

Bull's eye: Bull's eye catches during the year (2695 t), declined by 13% compared to 2010. They formed 2.3% of the demersal landings and were landed by trawlers (74.2%), gillnets (9.5%) and multiple gear combinations

(16.3%). *Priacanthus hamrur* (87.0%) and *Heteropriacanthus cruentatus* (13.0%) were the species landed. *P. hamrur* population in the fishery ranged from 181- 389 mm with the mean size of 259 mm. The exploitation rate was 0.60. The fishery was found in healthy state with spawning stock biomass forming 95% of the standing stock biomass.

Pigface breams: Pigface bream landings (793 t) increased by 181.1% compared to 2010. They formed 0.7% of the total demersal landings. The major gears that contributed to the fishery were OBM gillnets (78.4%), hooks and lines (8.3%), trawl nets (3.2%) and others (10%). The fishery was supported by four species, of which *Lethrinus mahsena* (190-240 mm) dominated with a share of 68% followed by *L. conchyliatus* (12%), *L. lentjan* (11%) and *L. elongatus* (9%).

Pomfrets: Pomfret catches (603 t) increased by 200% compared to that of 2010 and formed 0.5% of the total demersal landings. The major gears that contributed to the fishery were trawlers (64.2%), seine nets (32.5%), gillnets (0.7%) and non-mechanised units (2.6%). Bulk of the catch (99.5%) was contributed by *Pampus argenteus* and *P. chinensis* formed only 0.5%.

Catfishes: The catfish catches during the year (240 t) registered a tremendous (321.3%) increase which formed 0.2% of the total demersal landings. The major gears that supported the fishery were seine nets (54%), non-mechanised units (31.6%), combination gears (10.7%), trawl nets (1.7%), gillnets (1%) and hooks and lines (1%). The fishery which was almost collapsed seems to be on the revival path. Large sized catfishes are seen in the landing centres and in the markets in fairly good numbers.

Elasmobranchs: The total elasmobranch catch during 2011 was 3855 t. Sharks (62.7%), rays (28%) and skates (9.4%) were the major contributors. Hooks and lines (50.8%), trawlers (22.2%) and gillnets (16.9%) were the important gears that supported the fishery. Nine species of sharks were observed in the fishery along Malabar and the species were, *Carcharhinus limbatus* (43.7%), *Sphyrna zygaena* (18.9%), *Carcharhinus sorrah* (12%), *Alopias vulpinus* (10.8%), *Sphyrna lewini* (9.1%), *Carcharhinus leucas* (3.0%), *Rhizoprionodon acutus* (0.6%) and *Triaenodon obesus* (0.2%). Catch of *C. limbatus* was supported by 476-2324 mm population, but the fishery was mainly supported by 1200-1800 mm size groups. However, along the central Kerala >20 species were landed with major contributions by *Carcharhinus falciformis* (31.3%), *Carcharhinus limbatus* (17.6%), *S. lewini* (12.2%) and *Alopias superciliosus* (8.8%). The spawning stock biomass of *C. limbatus* was more than 20% of the annual stock at its unexploited level.

The important species among the rays in Malabar region were *Aetobatus narinari* (36.9%), *Pastinachus sephen* (20.6%), *Himantura bleekeri* (20.0%), *Himantura uarnak* (19.3%) and *Mobula* spp. (3.1%). However, more than 7 species were recorded from the central Kerala. The important species were *Mobula japanica* (68.9%), *Himantura fai* (19.2%) and *Taeniura meyeni* (4.4%).

Crustacean resources

The total crustacean landings during the year (44,861 t), increased by 1.9% compared to 2010. Crustaceans formed 6% of the total Kerala landings in 2011. The major contributors were penaeid prawns (78.5%), non-penaied prawns (14%), crabs (4.9%), stomatopods (2.5%) and lobsters (0.2%). About 84% of the crustaceans were landed by trawlers followed by seines (14%), gillnets 0.5% and others (1.7%).

Bull's eye landed at Kochi

Carcharhinus falciformis landed at Kochi

Dasyatis microps landed at Kochi

Penaeid prawn catches during the year (35,200 t) declined by 1.3% as compared to 2010. Non-penaeid prawn catches (6,260 t) increased by 187.5% and lobster catches (99 t) increased by 109.8% over 2010. Crab catches (2197 t) declined by 9.1% and stomatopod landings (1105 t) declined by 70.3% over 2010.

Prawn: Total prawn landings in 2011 (41,460 t) increased by 9.6% over 2010 which formed 92.4% of the crustacean landings. Penaeid prawns formed 84.9% of the prawn landings and non-penaeid prawns formed 15.1%. About 89.8% of penaeid prawns were caught from the inshore grounds and the rest 10.2% from the deepsea grounds. Among the inshore penaeid prawns, *Metapenaeus dobsoni* dominated with 58.6% and 38.1% in the landings of north and central Kerala, whereas, *Fenneropenaeus indicus* was the dominant species (98.3%) in Trivandrum. The other important species were *Parapenaopsis stylifera, Metapenaeus monoceros, M. affinis, Trachypenaeus curvirostris, Solenocera choprai, Penaeus monodon, Melicertus canaliculatus* and *P. semisulcatus*.

Shrimp landings at Puthiyappa

The deepsea penaeid catch was dominated by *Aristeus alcocki* (50.6%) followed by *Metapenaeopsis andamanensis* (49.0%) and *S. hextii* (0.3%). *Penaeopsis jerryi, P. investigatories* and *Hymenopenaeus aequalis* were also landed in small quantities. Among the deepsea non-penaeid prawns, *Plesionika spinipes* contributed 36.5%. Followed by *Heterocarpus gibbossus* (29%) and *H. woodmasoni* (29.5%). *Plesionika martia, Acanthephyra sanguinea* and *A. armata* were also landed in small quantities.

Crabs: The crab landings during the year (2197 t) declined by 9.1% compared to that of 2010 which formed 4.9% of the crustacean landings. 89.8% were landed by trawlers, 2.7% by gillnetters and rest (7.5%) by non-mechanised gears. *Portunus sanguinolentus* (61-145 mm CW) was the most important species in the crab landings throughout Kerala. It formed 52.4% in Malabar and 45% in the crab landings of central and south Kerala. *P. pelagicus* (71-140 mm CW) formed 37.6% at Malabar and 32.6% in the central Kerala. *Charybdis feriatus* (46-115 mm CW) formed 15.9% at central Kerala and 5.2% in Malabar. Other important species were *C. lucifera* (6%) and *Podophthalmus vigil* (4.6%), *Scylla serrata* in small quantities also landed at Vizhijium in bottom-set gillnet.

Growth and mortality parameters of important prawn resources of Kerala

Species	L_∞ (mm)	K ($year^{-1}$)	Z	M	F	E	L_{50}
M. dobsoni	125.6	1.0	5.38	1.18	4.20	0.78	74.20
P. stylifera	123	1.9	8.77	1.80	6.97	0.79	72.04
M. monoceros	181.3	1.1	6.02	1.13	4.89	0.81	83.10
M. affinis	161.2	1.3	6.35	1.30	5.05	0.79	87.00

Fishery related parameters of important prawn species of Kerala

Species	Length range (mm)	Mean size (mm)	Fishery dominant size group (mm)	L_r (mm)
M. monoceros	61-185	144	90-130	61
F. indicus	66-200	122	-	66
M. affinis	76-175	108	-	76
P. stylifera	46-125	78	80-100	46
M. dobsoni	51-120	78	80-100	51

Lobsters: Lobster landings during the year (99 t) increased by 109.8% compared to that of 2010. They formed 0.2% of the crustacean landings. About 65% were landed by trawlers and 35.5% by non-mechanised trap fishing and bottom-set gillnets. Slipper lobster, *Thenus unimaculatus* (81-265 mm CL) and spiny lobster, *Panulirus homarus* (90-248 mm CL) were the most important species landed during the year. *P. versicolor* were also landed in small quantities.

Molluscan resources

The total molluscan landings (34,869 t) declined by 1.6% compared to 2010. It formed 4.7% of the Kerala landings. About 73% was caught by trawlers followed by hooks and lines (21.3%), seine nets (2.4%) and gillnets

Fishery related parameters of important species of crabs in Kerala

Species	Size range Carapace width (CW in mm)		Mean size (CW in mm)		Dominant size (CW in mm)	
P. sanguinolentus	76-130	61-145	112.6	95.73	101-105	96-100
P. pelagicus	71-130	71-140	104.3	112.3	116-120	106-110
C. feriatus	46-115	61-105	74.6	69.85	76-80	66-70

and non-mechanised gears (3.7%). The major contributors were cuttle fishes (48%), squids (39.3%), octopus (11.2%) and gastropods (1.1%). Total cephalopod catch (34,467 t) declined by 1.1% in 2011. Groupwise contributions were, cuttle fishes (48.5%), squids (39.7%) and octopus (11.7%).

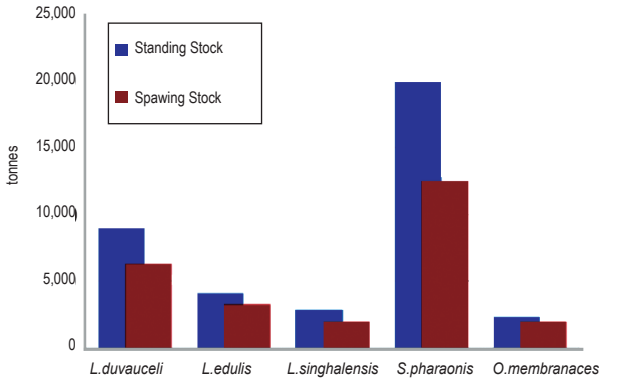
Bivalves: The bivalve landings in estuaries/lakes of Kerala was estimated as 49,680 t. *Villorita cyprinoides* contributed 77%, mainly from Vembanad Lake and *Paphia malabarica* formed 23%, mainly from Ashtamudi Lake. The brown mussel *(Perna indica)* production was 713.2 t at Trivandrum.

Gastropods: Gastropod exploitation, mainly at Kollam was 395 t, declined by 12.04% as compared to 2010. *Babylonia* sp. contributed 61% followed by *Xancus pyrum* 12% and *Bursa* sp. 11%. Among the cephalopods, cuttle fish (+0.4%) and octopus (+63.5%) catches increased whereas that of squids declined by 13% in 2011.

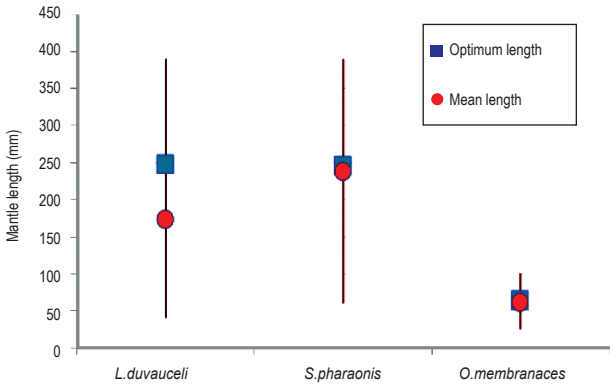
Cephalopods: Cuttle fish landings (16,721 t) were dominated by *Sepia pharaonis*. (90.1%). Other species landed were *Sepia ellptica* (5.5%) and *Sepiella inermis* (4.4%). *Sepia aculeata* landings were minimal. Squid catch (13,697 t) was supported mainly by *Loligo duvauceli* (78.2%), *L. singhalensis* (16.2%), *L. edulis* (5.1%), *L. chinensis* (0.3%) and *Sepioteuthis lessoniana* (0.2%). *Sthenoteuthis oualaniensis* and *Thysanoteuthis rhombus* ware also landed in stray numbers. Octopus fishery (4049 t) was supported by six species. However, *Octopus membranaceus* (52%), *O. dollfusi,* (25%) and *Cystopus indicus* (18%) were the dominant species. *O. aegina, O. cyanea* and other *Octopus* sp. were also landed occasionally. The major squid species *L. duvauceli* was exploited at 30% below the optimum length, the cuttle fish *S. pharaonis* at 3% below optimum length and *O. membranaceus* at above optimum length. The spawning stocks of all major species were above 60% of the standing stock. The proportion of juveniles in the trawl fishery was small; 1.6% in *S. pharaonis,* 0.7% in *L. duvauceli* and 7.2% in *O. membranaceus*.

Squids landed at Beypore

Standing and Spawning Stock Biomass (SSB) of cephalopod stocks in Kerala



Length based reference points of major cephalopod stocks in kerala



Status of exploitation of molluscan stocks in Kerala during 2011

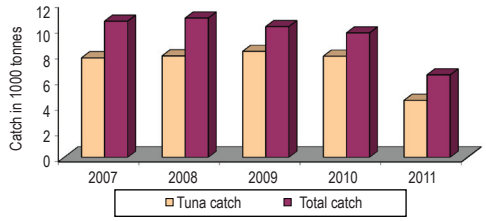
Population parameters of important molluscan resources of Kerala

Species	Length range (mm DML)	Mean size (mm DML)	Dominant group (mm)	Exploitation rate (E)	Spawning Stock (%)	Standing Stock (t)	L_{opt} (mm)
L. duvauceli	40-390	172.7	115-165	0.58	71.0	8900	247
L. edulis	30-380	139.1	95-145	0.76	79.0	4100	-
L. singhalensis	40-250	125.3	95-115	0.69	68.0	2850	-
S. pharaonis	40-390	237.2	215-275	0.54	63.0	19900	245
O. membranaceus	25-100	60.5	50-65	0.47	85.0	2300	635
P. indica	45-90	70.3	53-63	0.63	79.8	660	72

Pole & line fishing in Lakshadweep

Lakshadweep

Total catch by pole and line (P&L), troll line (TL), drift gillnet (DGN), encircling gillnet (EGN), hand line (HL) and long line (LL) was 6,428.5 t. Total catch declined by 33.7% in 2011. Tunas formed 69% (4,437.5 t) which declined by 43.7% over 2010. Other fishes and elasmobranchs formed 31% (1991 t), increased by 10% over 2010. Minicoy, Andrott and Agatti contributed 20.6%, 4.2% and 3% respectively to the total Lakshadweep catch. Their percentage contribution by different gears in tuna production were : P&L - 68.7%, HL-19.7%, TL-7.7%, DGN - 4% and LL - 0.01%. The tuna catch rates (kg unit^{-1}) in pole and line, TL, HL, DGN and LL were 319 kg, 26.6 kg, 58.2 kg, 27.2 kg and 3.3 kg respectively.

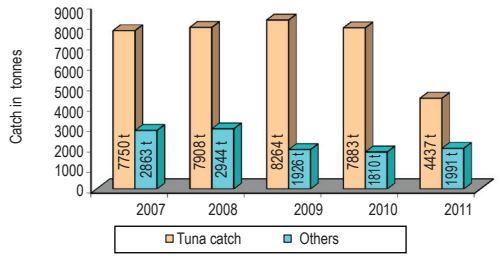


Tuna and total fish catch in Lakshadweep during 2008-2011

Tuna catch rates by different gears during 2010 and 2011

Gears	Catch /unit effort (kg)		+ / -	%
	2010	2011		
P&L	534.6	319.1	-215.5	-40.3
TL	26.9	26.6	-0.3	-1.1
DGN	48.0	27.2	-20.8	-43.3
HL	32.2	58.2	+26.0	+80.7
LL	0.0	3.3	-	-
Average	250.6	101.2	-149.4	-59.6

The species composition and percentage contributions in tuna landing during 2011 were, *K. pelamis* (36.9%), *T. albacares* (54.5%), *E. affinis* (5.5%), *A. thazard* (2.7%) and *G. unicolor* (0.3%), respectively. The same in 2010 were *K. pelamis* (76%), *T. albacares* (19.9%), *E. affinis* (2.3%), *A. thazard* (1.6%) and *G. unicolor* (0.1%), respectively. *T. albacares, E. affinis* and *G. unicolor* catches in 2011 increased by 53.9%, 34.2% and 87.6% respectively. *K. pelamis* and *A. thazard* catches in 2011 declined by 72.6% and 4.9% respectively. Drastic decline (-81.8%) was observed in the total fish landings of Agatti from 1038.2 t in 2010 to 189.3 t in 2011. The total landing of the Minicoy Island also declined (-49.4%) from 2615.2 t in 2010 to 1322.5 t in 2011. The total fish landing of Andrott declined (-24.7%) from 359.1 t in 2010 to 270.5 t in 2011.



Tuna and other fish catch in Lakshadweep during 2008-2011

The effort expended in pole and line fishing, the mainstay of the Lakshadweep fishery, declined by 51.1% in 2011, which resulted in the decline in the total landings of Lakshadweep in general and that of skipjack tuna in

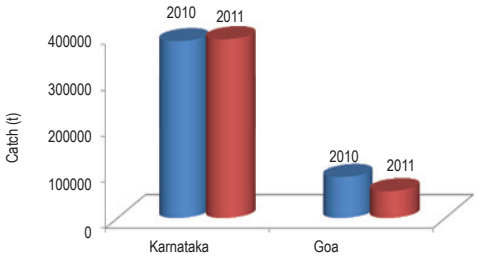
particular. The target fishing for skipjack using pole and line technique from the surface shoals, which were once plenty in the vicinity of the islands, was seriously affected due to their non-availability in 2011. This resulted in the drastic decline (-72.6 %) in skipjack catch from 5,994.8 t in 2010 to 1,640.1 t in 2011. Yellowfin tuna catch from the entire Lakshadweep waters increased (+53.9%) from 1,576.2 t in 2010 to 2,418 .0 t in 2011.

Adoption of combination of chumming with live baits and the use of artificial lures and fresh baits and concerted efforts using double pole with single hook technique resulted in the tremendous increase in the landings of *T. albacares*. The price of 'Mas' prepared from skipjack tunas soared to ₹ 700-750/kg and the 'Mas' prepared using kawakawa and frigate tuna were sold for ₹ 500-550/kg.

Skipjack tuna 'Mas'

Karnataka and Goa

The total marine fish landings in Karnataka estimated at 3,90,258 t during 2011 has registered a marginal increase by 1.2% as compared to 2010. Increased landings of the pelagic and the demersal resources by 7.7% and 2.1% respectively led to the overall increase in the total catch. The catch of crustaceans and the molluscs during the year declined by 16.8% and 35.3% respectively. Among the pelagic groups, increased catch was observed in the landings of oil sardine (8.7%) carangids (29.4%), mackerel (1 2.3%), black pomfrets (48%), seerfish (58.8%) and tunas (20.5%). The important demersal resources that showed increased landings were sharks (27.9%), rays (14.6%), eels (42.8%), other shads (33.2%), halfbeaks and fullbeaks (79.6%), threadfin breams (29.9%), silverbellies (36.2%) and silver pomfrets (57.4%). The annual revenue from fish landing by all gears put together in Karnataka was estimated at ₹1,49,278 lakhs.



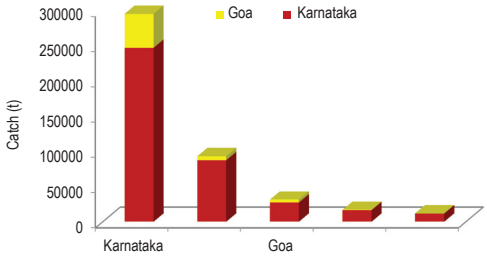
Total fish landing (t) in Karnataka and Goa during 2010 and 2011

The marine fish production in Goa continued to record a declining trend with the catch during 2011 being 58,469 t. The catch was 34.6% than that observed during 2010. Reduced catch was observed among all groups: pelagics (35.1%), demersals (39%), crustaceans (6.5%) and molluscs (68.6%). The annual revenue from fish catch by all gears put together in Goa was estimated at ₹18, 789 lakhs.

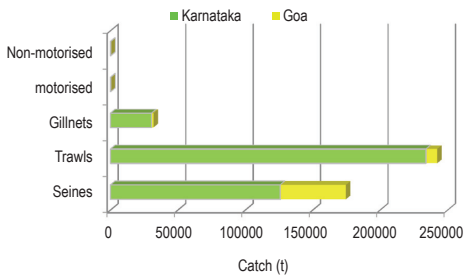
Pelagic fishes formed the bulk of the fishery both in Karnataka (63.4%) and Goa (82.4%). The demersal fishes formed 22.4% and 9.6%, crustaceans 7% each in Karnataka and Goa, molluscs 4.2% and 0.9% and other fishes 3% and 0.2% at Karnataka and Goa respectively. The major groups/species that contributed to the marine fish catch in Karnataka included oil sardine, mackerel, threadfin breams, ribbonfishes, scads, lizardfish, soles, squids, stomatopods and penaeid prawns.

Oil sardine landed in purse seine at Mangalore

In Goa, the species composition was similar with the dominance of mackerel followed by oil sardine. Horse mackerel and other carangids also made a significant contribution here. Oil sardine followed by mackerel was the most dominant resource in Karnataka and both the species registered



Major groups contributing to the marine fish production in Karnataka and Goa



Contribution of different gears to total marine fish production of Karnataka and Goa

an increasing trend during 2011. At Goa, mackerel followed by oil sardine formed the major resources. While the catch of oil sardine registered an increasing trend, mackerel registered a negative trend during 2011 in Goa.

The other groups that registered an increase in landings at Karnataka during 2011 included sharks, rays, eels, wolf herrings, other shads, halfbeaks and fullbeaks, threadfin breams, carangids, silverbellies, pomfrets, seerfish, tunas, barracudas, mullets, octopus and penaeid prawns. At Goa, sharks, rays, wolf herring, lesser sardines, *Thryssa,* other clupeids, halfbeaks and fullbeaks, croakers, pomfrets, barracudas, soles, crabs, stomatopods and cuttlefish registered increased catch during the year. Cephalopods, stomotopods, crabs, whitefish, lizardfish, soles, croakers, ribbonfish, rock cods, snappers, catfish, clupieds and *Stolephorus* spp. registered a negative trend this year as compared to 2010 in Karnataka. At Goa, mackerel, catfish, whitebaits, lizardfish, rockcods, threadfin breams, other perches, ribbonfish, carangids, silverbellies, whitefish, seerfish, tunas, penaeid prawns, squid and octopus registered a negative trend.

The mechanised, motorised and the non-mechanised sectors contributed 86.8%, 12.1% and 1.1% respectively to the catch in Karnataka and 90.8%, 6.7% and 2.6% respectively in Goa. While production by the mechanised and non-mechanised sector decreased by 1.1% and 35.8% respectively at Karnataka, the production by motorised sector increased by 29%. Whereas at Goa, the mechanised, motorised and non-mechanised sectors registered a steep decline by 29.1%, 39.2% and 81.7% respectively.

In Karnataka, the trawls were the major gear and contributed 59.94% of the catch and other gears included seines (32.25%), gillnets (7.81%) and other gears (0.01%). The purseseine was the dominant gear at Goa contributing to 83.29% of the total catch followed by trawls (14.08%), gillnets (2.43%) and others (0.21%).

A decrease in the landing by purseseines was observed both at Karnataka and Goa during the year. The rate of decrease being 0.3% and 38.2% respectively at Karnataka and Goa during the year. The catch by other seines registered an increase at Karnataka resulting in overall increase in the catch made by seines.

Major marine fish resources (t), percentage contribution, trend and value for Karnataka during 2011

Species	Catch 2011	% in total fish landings	Catch 2010	Trend (%) (+/-)	Value (₹ lakhs)
Oil sardine	83,544	21.4	76854	8.7	6,683.5
Mackerel	77,607	19.9	69,106	12.3	37,251.4
Threadfin breams	37,052	9.5	28,529	29.9	18,526.0
Cephalopods	16,452	4.2	25,439	-35.3	19,704.3
Carangids	30,872	7.9	23,858	29.4	5,322.0
Ribbonfishes	19,179	4.9	24,633	-22.1	7,671.6
Stomatopods	12,126	3.1	17,480	-30.6	727.6
Lizardfishes	14,474	3.7	16,180	-10.5	2,894.8
Penaeid prawns	13,270	3.4	13,247	0.2	17,251.0
Soles	9,269	2.4	10,913	-15.1	1,853.8
Rockcods	5,213	1.3	7,328	-28.9	1,824.6
Seerfish	7,924	2.0	4,991	58.8	11,796.5
Tunas	3,323	0.8	1,090	204.9	1,154.0
Stolephorus sp.	6,652	1.7	6,886	-3.4	1,663.0

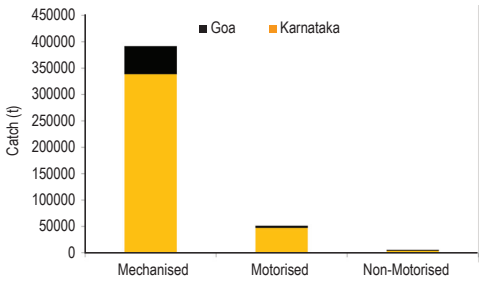
Major marine fishery resources (t), percentage contribution, trend and value for Goa during 2011

Species	Catch 2011	% in total fish landings	Catch 2010	Trend (%) (+/-)	Value (₹ lakhs)
Oil sardine	17,655	30.2	16,172	9.2	1,412.4
Mackerel	20,809	35.6	46,871	-55.6	9,988.3
Threadfin breams	621	1.1	1,841	-66.3	310.5
Cephalopods	497	0.9	1,585	-68.6	607.2
Carangids	3,410	5.8	6,057	-43.7	983.7
Ribbonfishes	1,090	1.9	1,362	-20.0	436.0
Stomatopods	2,560	4.4	549	366.3	153.6
Lizardfishes	27	0.1	78	-65.4	5.4
Penaeid prawns	1,279	2.2	3,646	-64.9	1,598.8
Soles	764	1.3	521	46.6	152.8
Rockcod	545	0.9	2,335	-76.7	190.8
Seerfish	187	0.3	334	-44.0	277.0
Tunas	2,003	3.43	2,493	-19.7	653.0
Stolephorus sp.	3	0.01	4	-93.7	0.8

The trawl catch too declined in Karnataka (1.2%) and Goa (18.8%) during 2011 as compared to 2010. The catch by gillnets registered an increase in Karnataka (50.3%) whereas in Goa the catch by this gear declined by 36.4% as compared to 2010. Among the major groups landed and studied at Karnataka, mackerel, ribbonfish, seerfish, cobia, whitefish, and squilla catch comprised of single species *viz., Rastrelliger kanagurta, Trichiurus lepturus, Scomberomorus commerson, Rachycentron canadum* and *Oratonepa* sp. The oil sardine, *Sardinaella longiceps* was the dominant (94.8%) sardine species. Threadfin breams, lizardfish, carangids, anchovies, tunas, penaeid prawns, crabs and cephalopods were represented by several genus and species.

Length distribution, sex ratio, maturity and food of 37 species exploited by major gears along Karnataka and Goa coasts were studied. In most of the species, the mean length of exploitation was found to be higher than the length at first maturity.

Growth and stock parameters of 24 dominant species were estimated. The exploitation rates were higher than desired levels in most species except *A. thazard, P. sanguinolentus, M. monoceros, P. stylifera and S. pharaonis*.



Contribution of different sectors to the total marine fish landings of Karnataka and Goa

Socio-economic analysis

A structured interview schedule was developed to assess the techno-economic efficiency of fishing crafts in Dakshina Kannada and to measure the attitude of fishermen towards sustainable fishery resource management based on Likert's summated rating scale. Data was collected from 30 trawl and 30 purseseine owners and analysed during the year. Data pertaining to the techno-economic feasibility of different crafts and gears was collected from the owners of mechanised crafts such as singleday trawlers, multiday trawlers and purseiners from Mangalore Fisheries Harbour, Dakshina Kannada District. The average operational cost per trip of purseseines was ₹15,175. The fixed cost was ₹65 lakhs. About 15% of purseiners were observed to be used as dual operation boats i.e. used both as purseiners and trawlers. With respect to marketing of fish, it was observed that, 87.50% of the boat owners availed loan facilities from public finance and only 12.50% depended on private finance for loans. The boat owners did not avail loan facilities from other sources such as, money lenders, friends, SHG's and specific buyers who

Species diversity among the major groups landed at Karnataka

Genera/species	%	Genera/species	%
Finfishes			
Anchovies	100.0	**Threadfin breams**	100.00
Encrasicholina devisi	78.9	*Nemipterus randalli*	41.0
E. buccaneeri	0.1	*N. japonicus*	59.0
Stolephorus waitei	18.6	**Flatfish**	100.0
S. commersoni	2.3	*Cyanoglossus macrostomus*	95.4
S. indicus	0.1	*C. bilineatus*	1.6
Sardines	100.0	*C. puncticeps*	1.0
Sardinella longiceps	93.3	*Psettodes erumei*	1.1
S. gibbosa	3.0	*P. arsius*	0.9
S. fimbriata	2.0	**Sharks**	56.4
S. albella	1.0	*Iago omanensis*	46.4
S. brachysoma	0.7	*Sphyrna lewini*	25.4
Carangids	100.0	*Scoliodon laticaudus*	14.2
Decapterus russelli	52.6	*Carcharhinus limbatus*	11.5
D. macrosoma	3.0	*Rizoprionodon acutus*	2.5
Megalaspis cordyla	23.7	**Rays**	
Scomberoides tala	2.1	*Mobula mobular*	25.0
Formio niger	3.7	*Himantura imbricata*	48.9
Tunas	100.0	*H. gerrardi*	21.4
Katsuwonus pelamis	0.6	*H. bleekeri*	2.1
Thunnus tonggol	7.8	*H. uarnak*	1.4
Euthynus affinis	86.0	*Rhinoptera javanica*	1.1
Auxis thazard	5.2	**Bull's eye**	
Others	0.4	*Priacanthus hamrur*	99.0
Billfishes		*Cookeolus japonicus*	1.0
Istiophorus platypterus	100.0		
Lizardfishes		**Pufferfish**	
Saurida tumbil	91.9	*Lagocephalus inermis*	99.0
Saurida undosquamis	8.1	*Lagocephalus sceleratus*	1.0
Shellfishes			
Penaeid prawns	100.0	**Cephalopods**	100.0
Fenneropenaeus indicus	16.6	**Cuttlefish/squid/octopus**	
Penaeus monodon	0.5	*Sepia pharaonis*	24.2
Metapenaeus dobsoni	17.1	*Sepiella inermis*	1.8
M. monoceros	40.7	*Sepia elliptica*	2.2
Parapenaeopsis stylifera	14.8	*Sepia prashadi*	0.8
M. affinis	0.1	*Sepia trygonina*	0.2
Solenocera spp.	9.1	*Loligo duvauceli*	40.1
P. canaliculatus	1.2	*L. edulis*	17.4
Crabs	100	*L. singhalensis*	8.3
Portunus pelagicus	37.7	*O. membranaceus*	4.8
P. sanguinolentus	44.1	Other octopus	0.3
Charybdis feriatus	18.2		

Middlemen waiting to procure fish at the Mangalore Fisheries Harbour

procure fish from boat owners.The operational cost/trip of trawlers was ₹ 1,171. The fixed cost was ₹ 8,40,000. The operational cost/trip for a multiday trawler with an average number of 9 days of operation/trip has been worked out as ₹ 2,18,415.

Important biological indicators of dominant species landed in Karnataka

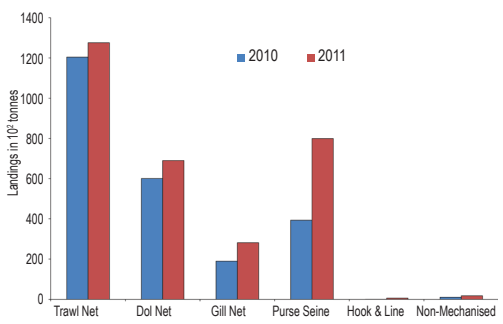
Species	Length range (cm)	Mean (cm)	Sex ratio	L_m (cm)
S. longiceps	11.0-21.5	16.4	1.0:1.0	15.0
R. kanagurta	6.5-29.0	21.0	1.0:0.9	17.5
T. lepturus	28.0-108.0	68.0	1.0:1.4	60.0
D. russelli	6.0-25.0	16.6	1.0:1.3	16.0
D. macrosoma	17.0-27.4	21.0	1.0:1.1	
M. cordyla	10.0-43.0	25.8	1.0:0.9	25.0
E. devisi	4.4-11.0	8.5	1.0:0.9	6.8
S. waitei	5.0-11.2	91	1.0:0.9	8.0
R. canadum	24.0-136.0	45.0	1.0:1.0	
S. commerson	12-86	36		70
N. japonicus	5.0-35.0	13.7	1.0:0.6	18.8
N. randalli	5.0-29.0	13.8	1.0:0.4	17.2
L. lactarius	7.0-28.0	15.0	1.0:0.9	13.2
C. macrostomus	6.0-16.5	12.7	1.0:1.2	11.5
L. inermis	10.0-44.0	28.7	1.0:1.1	
S. laticaudus	22-68		1:0.84	NA
I. omanensis	20-68	38	1:0.64	NA
P. stylifera	5.1-12.0	8.2	1:1.03	8.3
M. dobsoni	5.1-11.0	7.6	1:1.0	7.1
M. monoceros	9.1-18.0	12.4	1:1.15	11.6
S. choprai	5.1-12.0	8.6	1:1	6.5
P. pelagicus	8.6-12.5	10.0	1: 0.68	9.6
P. sanguinolentus	6.1-14.0	9.9	1:1.29	8.96
C. feriatus	4.1-11.0	6.6	1:0.88	7.1
L. duvaucelli	1.0-34.0	13.3	1.0:0.8	11.0
L. edulis	4.0-29.0	10.4	1.0:0.8	
L. singhalensis	8.0-22.0	12.2	1.0:0.5	
S. pharaonis	4.0-37.0	13.8	1.0:0.8	12.9
S. inermis	2.0-10.0	6.3	1.0:1.5	
S. elliptica	4.0-22.0	9.1	1.0:1.5	9.6
S. prashadi	7.0-21.0	12.0	1.0:0.3	
S. trygonina	*5.0-10.0*	*7.4*	*1.0:0.9*	
O. membranaceus	3.0-11.0	6.1	1.0:0.7	
R. kanagurta	12.5-28.5	21.0	1.0:0.9	17.5
S. commerson	44.0-126.0	71.0	1.0:1.6	70.0
M. cordyla	16.0-44.0	29.3	1.0:0.8	17.5
T. tonggol	30.0-64.0	45.0	1.0:1.4	
E. affinis	24.0-64.0	42.0	1.0:0.8	43.0
A. thazard	20.0-48.0	35.0	1.0:1.2	30.5

Purse seiners at Malpe Harbour

Fishery related parameters of major resources landed in Karnataka

Species	L_m (cm)	L_∞ (cm)	K (yr^{-1})	t_o	L_{opt} (cm)	M	Z	E
R. kanagurta	17.5	31.8	1.1	-0.0833	19.6	2.10	8.75	0.76
S. longiceps	15.0	22.8	0.9	-0.1124	13.8	1.79	5.40	0.67
E. devisi	6.8	11.7	1.59	-0.0660	6.9	2.81	15.7	0.82
S. waitei	8.0	11.5	1.5	-0.0728	6.8	2.67	8.99	0.70
M. cordyla	25.0	49.6	0.7	-0.1117	31.1	1.49	3.70	0.60
S. commerson	70.0	162	0.78	-0.0742	106.7	1.61	6.43	0.75
D. russelli	16.0	28.4	0.7	-0.1302	17.4	1.49	6.29	0.76
E. affinis	43.0	79.0	0.89	-0.0807	26.8	1.78	4.77	0.63
A. thazard	30.5	49.0	0.96	-0.0855	30.7	1.88	3.34	0.44
T. lepturus	60.0	134	0.86	-0.0720	87.6	1.78	6.03	0.70
N. randalli	18.8	31	0.78	-0.1170	19.1	1.78	4.52	0.61
N. japonicus	17.2	33.5	0.89	-0.1021	20.7	1.78	6.95	0.74
C. macrostomus	11.5	17.8	0.95	-0.1142	10.7	1.86	6.70	0.72
L. lactarius	13.2	29	1.0	-0.0948	17.8	1.94	4.84	0.60
M. dobsoni	7.1	11.9	1.2	-0.0984	7.0	2.20	6.13	0.64
M. monoceros	11.6	12.3	1.5	-0.0714	7.3	2.80	6.17	0.55
P. stylifera	8.35	19.2	1.4	-0.0701	11.6	2.80	6.56	0.57
S. choprai	6.5	12.0	1.2	-0.0982	7.1	2.23	6.10	0.63
P. sanguinolentus	8.96	16.9	1.9	-0.0432	10.1	2.9	2.15	0.43
P. pelagicus	9.6	17.3	1.3	-0.0800	10.4	2.5	3.58	0.62
C. feriatus	7.1	13.5	1.2	-0.0951	8.0	2.2	4.21	0.66
L. duvaucelli	11.0	42.1	0.9	-0.0949	26.2	0.82	6.31	0.87
S. elliptica	9.6	17.7	0.85	-0.1369	10.6	1.0	5.77	0.83
S. pharaonis	12.9	42.0	1.2	-0.0696	26.1	2.23	5.5	0.59

Maharashtra



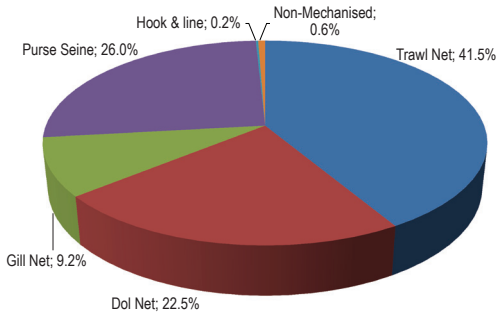
Comparison of gear-wise landings of Maharashtra in 2010 and 2011

The marine fish landings in Maharashtra during 2011 are estimated at 3.07 lakh t. The pelagic finfishes contributed 47.7%, demersal 23.3%, crustaceans 23.7% and molluscs 4.3% to the total landings. The total fish landings recorded 28% increase over 2.39 lakh t in the previous year. The major fishing gears that supported the fishery were trawl net (41.5%), purse seine (26%), bag net (23.9 %) and gillnet (7.3 %), while prominent species/ groups that contributed to the fishery of the state were oil sardine (13.8%), non-penaeid prawns (12.9%), Indian mackerel (9.4%), penaeid prawns (8.9 %), croakers (8.9%), ribbonfishes (5.5%) and Bombayduck (4.4 %). It is very unusual to note that oil sardine and mackerel have emerged as the major species in Maharashtra relegating traditional Bombayduck to 7th position. As a result, fish landings by purse seining gained prominence to second position after trawl, leaving behind traditional bag net fishing. The catch rates in purse seine remained at the highest position (569.3 kg h^{-1}) followed by bag net (42.0 kg h^{-1}), trawl (23.4 kg h^{-1}) and gillnet (13.7 kg h^{-1}).

Owing to abundance of oil sardine and mackerel and poor catch of penaeid prawns in the coastal waters, many shrimp trawlers in the state switched over to purse seining. In addition, about 110 traditional crafts and gillnetters commenced mini purse seining (ring seine operations) for sardines for the first time in the state.

The value of total fish landings in the state at first point of sale has been estimated as ₹2,875 crores. Major share of revenue came from trawling (55.5%) followed by dol netting (22.45%), purse seining (12.9%), gill netting (8.4%), hooks and line fishing (0.1%) and non-mechanised fishing (0.8%). Purse seining improved the performance in terms of revenue compared to 2010 (5.3%) due to heavy landings of *Sardinella longiceps* during the year.

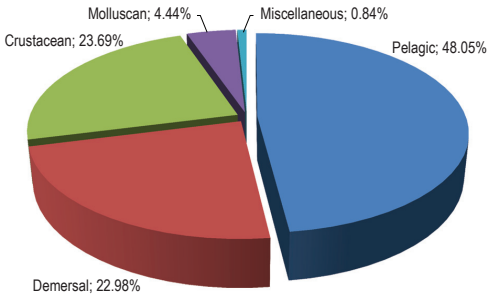
Although total fish landings in Maharashtra showed 28% improvement, the revenue recorded only 14% enhancement as compared to ₹2,515 crores in 2010. The lower revenue is attributed to meagre price and revenue from oil sardine despite enormous landings. The sardine catch was disposed mostly for poultry feed at ₹3 kg^{-1} that was lower than tiny non-penaeid prawns and the trawl bycatch. Due to this, the estimated average price of fish during the year also reduced from ₹111.8 kg^{-1} in 2010 to ₹94 kg^{-1} in 2011; decline in catch of some high valued resources *viz*., cuttlefishes and lobsters (-18% and -30% respectively) also lowered the average fish price. However, the retail price of some of the varieties such as silver pomfret (72.3%), black pomfret (53%), seerfish (43.3%) and mackerel (22.54%) showed substantial increment in price.



Gear-wise composition of fish landings in Maharashtra in 2011

Pelagic resources

Clupieds: *Sardinella longiceps* contributed 13.8% (42,275 t) to the overall fish production in Maharashtra which formed the largest resource that ever landed in Maharashtra. The species showed 98.5% increase in catch as compared to the previous year and purse seine was the major gear that caught *S. longiceps* (89%). Other sardines and shads contributed 1.3% to the total catch followed by anchovies (0.6%) and herrings (0.42%). Although purse seiners operated in Ratnagiri showed good size of oil sardine (110-204 mm), the catch in mini purse seine comprised of juveniles up to 100 mm in total length and therefore their use were mostly confined to poultry feed and fishmeal. Mature and gravid sardines were observed in October and November. Copepods, tintinids, *Coscinodiscus, Fragilaria* and *Nitzchia* were the major food items.



Percentage contribution of various resources to the fisheries of Maharashtra

Golden anchovy *Coilia dussumieri* contributed 2.7% (8,228 t) to the total marine fish landings but recorded 11% decline over the last year. Trawl landings contributed 56%, while bag net formed only 30% of the total catch. Abundance of the species was maximum during October-December and in May.

Indian mackerel: With 28,745 t catch, it contributed to 9.4% forming the third largest resource in Maharashtra. Almost 75% of the mackerel landing in Maharashtra was contributed by purse seine followed by 9.7% by trawl, 8.4% by gillnets and nearly 5% by the shore seines (rampani). The catch was maximum in October and April. The size range was 140-244 mm TL with dominant mode at 190-194 mm and mean size at 193 mm. Almost all the females were in mature and gravid condition during September and November. Gut analysis of 565 specimens showed dominance of copepods, amphipods, *Ceratium, Peridinium, Coscinodiscus* and *Nitzchia.*

Oil sardine landings at Sassoon Docks, Mumbai

Bombayduck: With estimated catch of 13,565t, it formed nearly 4.4% of the total fish catch. Of this, 53% was contributed by dol nets and the remaining 46.5% by trawlers. The catch rate was maximum in August (4.1 kg h^{-1}) which declined gradually to 1.03 kg h^{-1} in December. The size ranged from 75 to 344 mm in TL with mean at 230 mm. Sex-ratio showed dominance of females in all the months except in May. Mature and gravid females were noticed throughout the year except in August when all the

Sundrying of Bombayduck at Vasai, Maharashtra

females were in immature state. Index of relative importance (IRI) for food contents showed *Nematopalaemon tenuipes* (46.5%) as the most favourite food followed by *Acetes* spp. (21.8%) and *Coilia dussumieri* (13.3%). Cannibalism was also noticed as IRI showed 17.4% prevalence of juvenile Bombayduck.

Ribbonfishes: Ribbonfish contributed about 5.5% (16,904 t) in the total fish catch of Maharashtra. Trawl net contributed to the major catch (71%) of this resource. *Trichiurus lepturus* was the major species with size range of 390-1089 mm and mean size of 666 mm in TL. The occurrence of mature and gravid females was maximum in February (84%) and minimum in November. *Acetes* spp. formed the dominant food item (IRI 53.5%).

Carangids: The estimated landings of carangids along Maharashtra coast was 12,526 t which formed 4.1% of the total catch. Nearly 45% of the carangid catch was contributed by horse mackerel, *Megalaspis cordyla,* followed by leather jacket (10%). Almost half the catch (47%) of horse mackerel and leather jacket was from purse seine followed by trawl net (23%), gillnet (21%) and dol net (9%).

Seerfishes: Seerfishes contributed 5,166t (1.6%) to the total catch in which *S. commersoni* (68%) and *S. guttatus* (32%) were the major species contributing to the fishery. About 60% of the total seer fish catch was contributed by gillnets followed by trawl net (12%). The catch was maximum in November and March but the catch rate was the highest in October. Size of *S. guttatus* ranged between 210-709 mm with mean size at 340 mm. Nearly 75% females in February were in mature and gravid condition.

Ribbonfish landings at Naigaon, Maharashtra

Tuna: The estimated catch of tuna in 2011 was 5,057 t that recorded 9.2% increase over the last year. During the year, 57% of tuna were caught by purse seine, 30% by gillnets and 10% by multi-day trawlers. *Euthynus affinis* was the most dominant species (53.1%), followed by *Auxis thazard* (26%), *Thunnus tonggol* (16%) and others (4.9%). Size range of *E. affinis* was 280-660 mm with small sizes dominating in August (380-440 mm) and larger ones in May (580-620 mm). *A. thazard* ranged in size between 240-440 mm, but those in 360-400 mm size formed the mainstay of the catch in trawlers.

Wolf herring: Estimated catch of wolf herring was 1300 t mainly exploited by multi-day trawlers (37%) and gillnetters (35%). *Chirocentrus nudus* was the dominant species with size range of 75-680 mm with dominant modes at 420 mm and 520 mm.

Demersal resources

Elasmobranchs: Elasmobranch catch (4,905 t) along the coast exploited by trawlers, gillnetters and dol netters was 1,755 t, 2,508 t and 602 t respectively. The contribution of this resource in the gears was 1.4%, 8.8% and 0.9% respectively. Nearly 51% of elasmobranchs landed was exploited by the gillnetters. Sharks were the dominant group (80%) followed by rays 17.2% and skates 2.9%. *Scoliodon laticaudus* (92.5% in trawl, 77% in gillnets and 90% in dolnets) was the dominant species in these gears, whereas *Himantura alcockii* (39%) and *Rhynchobatus djeddensis* (92%) were the most dominant among rays and skates respectively.

Sailfish landings at New Ferry Wharf, Mumbai

Eels: During 2011, 784 t of eels were landed in Maharashtra that formed 0.25% of the total fish landings. The eels were mainly caught by trawl net (51.3%) followed by dol net (21.4%) and gill net (20.5%). *Congresox talabonoides* was the most important species (55.7%) followed by *Muraenesox cinereus* (39.3%) and *C. talabon* (4.8%). Size of *C. talabonoides* ranged between 280-1200 mm with mean size of 588 mm.

Pomfrets: Estimated catch of pomfrets in trawl, gillnets and dol nets in Maharashtra was 1,154 t, 1,383 t and 1,970 t respectively. Nearly, 44% pomfret catch was exploited by dol nets. In the total fish catch, pomfrets contributed 0.9% in trawl, 4.88% in gillnet and 2.85 % in dol nets. Among the pomfrets, *Pampus argentius* was the most dominant species in trawl (51.8%), gillnet (80%) and dol net (90.7%). The size range of silver pomfret in dol net was 50-330 mm (mean size 169 mm), in gillnets 120-310 mm (202.6 mm) and in trawl 60-320 mm (154.2 mm). Thus, trawlers landed mostly undersized pomfrets but by virtue of landings, dol nets caused more damage to silver pomfrets. Biology of black pomfret *Parastromateus niger* showed size range between 120-380 mm with annual mean size at 273 mm. Mature and gravid females were noticed in April (15%) and during August-September (30.1-54.5%). The species showed mainly *Acetes* spp. and squids in the stomach and gullet.

Landings of eel at New Ferry Wharf

Lizardfishes: Lizardfishes contributed 955t in total fish catch of Maharashtra, landed exclusively by bottom trawlers. They constituted 0.75% of the total catch with a catch rate of 0.18 kg h^{-1}. *Saurida tumbil* (97.4%) was the dominant species in lizardfish landings followed by *S. undosquamis* (2.6%).

Polynemids: Estimated catch of polynemids in trawl net in Maharashtra was 398 t with catch rate of 0.07 kg h^{-1} which formed 0.3% of the total fish catch. The catch recorded 8% decline compared to previous year. Polynemid catch was mainly contributed by *Polynemus heptadactylus* (92%).

Landings of Koth at New Ferry Wharf

Groupers: Groupers were mainly landed by the trawlers (2,202 t) forming about 1.7% of the total catch at catch rate of 0.4 kg h^{-1}. The catch and effort increased by 3.3% and 23.4% respectively, whereas catch rate and percentage contribution of groupers declined by 16.3% and 11% in comparison to previous year. The relative species abundance showed the dominance of *Epinephelus diacanthus* (84.9%) followed by *E. tauvina* (10.2%) and *E. latifasciatus* (3.8%). *E. lanceolatus* was the least dominant in 2011 (0.09%) in the grouper catches. Almost 81% of *E.diacanthus* catch was dominated by juveniles and the length range was 80-499 mm.

Croakers: Sciaenid landings along the Maharashtra coast by trawlers, gillnetters, dol netters and purse seiners were 1,7956, 2,933, 1,418 and 4,994 t respectively. The catch rate in kg h^{-1} was 3.30,1.47, 2.56 and 35.55 respectively. In trawl catch, sciaenids decreased by 4.3% as compared to previous year whereas in gillnets it increased by 64.4%. Relative abundance showed dominance of *Johnius vogleri* (31.3%) followed by *J. macrorhynus* (24.3%), *Otolithes cuvieri* (22.4%) and *Otolithoides biauritus* (11.4%). Appearance of *Pennahia macropthalamus* in the catch was significant (0.48%) during period.

Bag netters at New Ferry Wharf, Mumbai

Catfishes: Catfish catch along the Maharashtra coast exploited by trawlers, gillnetters, dol netters, and purse seiners was 2,048, 1,676, 733 and 2,599 t respectively. The contribution of this resource in these gears was 1.1%, 5.9%, 1.1% and 3.3% respectively in the total fish landings. In comparison to previous year, catfish catch increased in trawl net and purse seine by 14.2% and 51.4% but declined in dol net and gillnets by 45% and 6% respectively. Overall catfish catch decreased by 7.8%. The contribution of major catfish species landed were *Osteogeneiosus militaris* (40.2%), *Tachysurus dussumieri* (20.5%), *T. teanuispinis* (17.1%) and *T. coelatus* (17%).

Nemipterids: Nemipterids exploited exclusively by trawlers amounted to 12,636 t with annual catch rate of 2.32 kg h^{-1} which contributed 9.9% in total

fish landings of the state. In comparison to previous year, nemipterid catch declined by 14.5%. The major nemipterid species landed were *N. japonicus* (58.9%), *N. randalli* (28.7%) and *N. bipunctatus* (10.3%).

Crustaceans resources

The total crustacean landings (72,694 t) during the year showed 16.8% increase over 2010. Major contributors were non-penaeid prawns (54.39%), penaeid prawns (37.46%), stomatopods (6.87%), crabs (1.02%) and lobsters (0.06%). The crustaceans were mainly landed by dol netters (54.3%) and trawl netters (44.1%).

Purse seine fleet at Sassoon Docks, Mumbai

Prawns: Prawns formed 92% of the crustacean landings. Among the shrimps, non-penaeids contributed 59.2% and penaeids 40.8%. During the year, catch rate of prawns declined by 24% to 4.3 kg h^{-1} which appears to be critical benchmark for the shrimp trawl operations as most of them were either laid up or switched over to purse seining. Among the penaeid prawns, *P. stylifera* dominated the trawl catch (27.9%) followed by *M. affinis* (27.2%), *M. monoceros* (19.5%) and *S. crassicornis* (11.9%). Among the non-penaeid prawns, *N. tenuipes* dominated the fishery with 53.1% followed by *Acetes* (33.7%) and *Exhippolysmata ensirostris* (20.2%).

Lobsters: Lobsters, with estimated catch of 172 t formed 0.25% of the crustaceans landings; 62% were landed by trawlers and 38% by gillnetters. *Panulirus polyphagus* was the only species in the catch. The catch was maximum in February and October in trawl. The size of *P. polyphagus* ranged between 65-345 mm in TL, but those in 115-165 mm formed the mainstay of the trawl catch with annual mean size of 167 and 181 mm for the males and females respectively. In trawls, juveniles (<260 mm TL) formed 82.7% of the catch. Berried females were observed mainly during August-September (48%).

Crabs: Crabs with 748 t of catch formed 1% of the crustacean landings. They were mostly landed by trawlers (70%) and the rest 30% by other gears. The landing was maximum in March and October. *C. cruciata* (59.3%) accounted for the bulk followed by *P. sanguinolentus* (22.3%), others (10.7%) and *P. pelagicus* (0.8%). The catch was mostly constituted by adults and the juveniles formed <2%.

Spiny lobsters landed at New Ferry Wharf

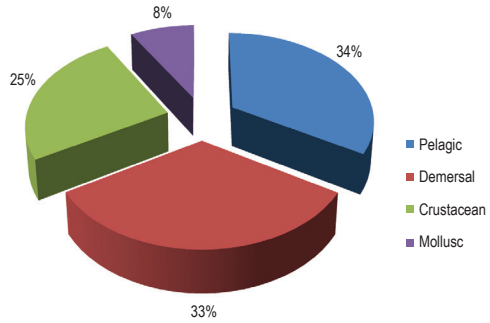
Molluscan resources

Cephalopods: The estimated catch was 13,544 t that formed 4.4% of the total marine fish landings which recorded 7% decline over 2010. Shrimp trawl modified for catching squid and cuttle fish was the major gear used with catch per hour of 2.47 kg. In the catch, squid *Loligo duvauceli* formed 51.4% followed by *Sepia aculeata* (22.3%), *S. pharaonis* (16%) and *S. inermis* (9.9%). Octopids (mainly *Cistopus indicus*) formed about 0.4% of the total cephalopod landings. Size (DML) of *L. duvauceli, S. pharaonis S. aculeata* and *C. indicus* were 20-309 mm, 70-299 mm, 40-129 mm and 30-199 mm respectively. Fecundity of *L. duvauceli* ranged between 740-14,924 eggs.

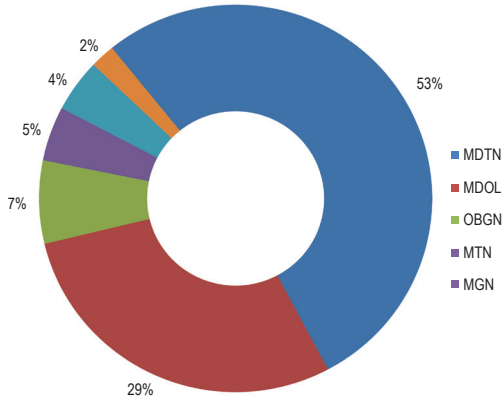
Important population parameters of the resources landed in Maharashtra

Species	L_∞ mm	K (annual)	Z	M	F	E	E_{max}	Remarks
H. neherius	400	0.75	4.01	1.37	2.64	0.66	0.60	over-exploited
C. dussumieri	214	1.45	4.38	2.5	1.88	0.43	0.55	under-exploited
S. longiceps	197	1.0	5.6	2.02	3.58	0.64	0.68	under-exploited
R. kanagurta	280	1.3	7.93	2.16	5.77	0.73	0.69	over-exploited
P. dussumieri	658	0.58	3.48	1	2.48	0.71	0.55	over-exploited
P. tenuispinis	597	0.4	1.41	0.81	0.6	0.43	0.58	under-exploited
N. caelatus	564	0.58	2.07	1.05	1.02	0.49	0.59	under-exploited
O. militaris	598	0.65	2.17	1.11	1.06	0.49	0.52	under-exploited
N. japonicus	350	0.91	4.89	1.61	3.28	0.67	0.46	over-exploited
N. randalli	284	0.84	3.78	1.62	2.16	0.57	0.53	over-exploited
J. macrorhynus	346	0.65	3.82	1.29	2.53	0.66	0.62	over-exploited
J. vogleri	392	0.5	3.21	1.05	2.16	0.67	0.60	over-exploited
J. sina	276	1.19	4.86	2.05	2.81	0.58	0.58	optimally exploited
O. cuvieri	414	0.88	4.44	1.5	2.94	0.66	0.56	over-exploited
P. diacanthus	1420	0.52	1.65	0.74	0.91	0.55	0.43	over-exploited
O. biauritus	1820	0.51	3.78	0.7	3.08	0.81	0.42	over-exploited
E. diacanthus	560	0.62	7.9	1.13	6.77	0.86	0.49	over-exploited
S. laticuadus Male (M)	610	0.52	1.77	0.96	0.81	0.46	0.60	under-exploited
S. laticuadus Female (F)	638	0.54	1.69	0.97	0.72	0.43	0.73	under-exploited
P. argenteus	355	0.76	2.93	1.22	1.71	0.58	0.53	over-exploited
S. tumbil	494	0.73	2.64	1.26	1.38	0.52	0.52	optimally exploited
P. heptadactylus	300	0.63	4.23	1.32	2.91	0.69	0.58	over-exploited
T. lepturus	127	0.68	4.11	0.93	3.18	0.77	0.64	over-exploited
P. stylifera (M)	115	1.8	8.3	3.45	4.85	0.58	0.68	under-exploited
P. stylifera (F)	147	1.8	12.47	3.2	9.27	0.74	0.64	over-exploited
M. affinis (M)	163	1.9	7.47	3.22	4.25	0.57	0.66	under-exploited
M. affinis (F)	210	1.7	11.48	2.79	8.69	0.76	0.65	over-exploited
S. crassicornis (M)	108	1.9	7.31	2.82	4.49	0.61	0.70	under-exploited
S. crassicornis (F)	129	1.9	6.4	3.44	2.96	0.46	0.64	under-exploited
M. monoceros (M)	200	1.8	7.2	2.94	4.26	0.59	0.64	under-exploited
M. monoceros (F)	233	1.7	5.27	2.71	2.56	0.49	0.61	under-exploited
F. merguensis (M)	205	2	12.36	3.13	9.23	0.75	0.67	over-exploited
F. merguensis (F)	252	1.9	8.09	2.85	5.24	0.65	0.64	over-exploited
L. duvaucelli	370	0.95	4.15	1.86	2.29	0.55	0.55	optimally exploited
S. aculeata	206	1.05	6.52	2.01	4.51	0.69	0.60	over-exploited
S. inermis	106	0.52	2.72	1.2	1.52	0.56	0.56	optimally exploited
S. pharaonis	430	0.77	5.66	1.59	4.07	0.72	0.55	over-exploited
C. indicus	250	0.91	2.73	1.22	1.51	0.55	0.65	under-exploited

Gujarat



Contribution by major groups to marine fish landing in Gujarat during 2011



Contribution by different gears to the marine fish landing in Gujarat during 2011

Ribbon fishes landed by trawlers in Nawabunder

The estimated marine fish production from Gujarat in 2011 was 6,27,265 t showing considerable increase of 19.32% from that of previous year. For the first time in the last 10 years, the marine fish production in Gujarat crossed 6 lakh tonnes mark. Almost all the major resources recorded positive growth except the molluscan resources. The demersal landings were estimated as 2 lakh t which formed 33% of total production and the pelagic resource contributed 2.04 lakh t (34%) followed by crustacean resources 1.5 lakh t, (25%) and molluscs 0.52 lakh t (8%). The maximum landings were that of non-penaeid prawns (1.1 lakh t) followed by ribbonfishes (81,541 t), sciaenids (61,018 t), bombayduck (49,195 t) and catfishes (34,120 t).

Mechanised multi-day trawlers contributed 53% of the total fish landing in Gujarat followed by mechanised dolnetters (29%) and outboard gillnetters (7%). The landing by mechanised multi-day trawlers decreased by 8% while that by mechanised dolnetters increased by 6% over the previous year.

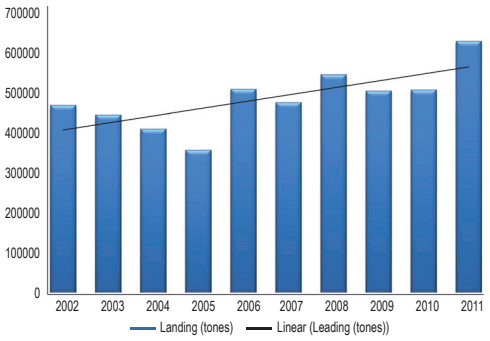
Pelagic resources

Bombayduck: The estimated total catch of Bombayduck in Gujarat during 2011 was 49,195 t, which formed 7.8% of the total fish landing of Gujarat and nearly 24% of the landing of pelagic resources of the state. The landings by dolnets from the inshore grounds of Nawabunder, Rajpara and Jaffrabad alone were 29,686 t, which is nearly 23% of the total dolnet catches with a catch rate of 457 kg unit^{-1} month^{-1} for an effort of 67,946 units. The catch and catch rates were higher from October to December forming nearly 66% of the total landing of Bombayduck in the area. Single species *Harpadon nehereus* formed the entire catch of bombayduck here and the size ranged from 180 to 309 mm with a mean of 229.1 mm and distinct modes at 187 mm, 217 mm, 267 mm and 247 mm. Sex ratio of 1:1.1 was recorded for the species with high proportion of immature females occurring all through the season and gravid/spent females during October. The relative fecundity was 282.3 with ova diameter ranging from 0.18 to 0.9 mm. The analysis of food components revealed that *Acetes*, other non-penaeid prawns, clupeoids, codlets and juveniles of fishes formed the diet of this species.

Ribbonfish: The estimated ribbonfish landings in Gujarat during 2011 was 81,541 t. This was 13% of the total fish landings and 40% of the landings of pelagic resources in Gujarat during the period. Mechanised multiday trawlers alone contributed 74% of the total ribbonfish landings and the remaining by single day trawlers, mechanised dolnetters and gillnetters. Contribution by trawlers at Veraval alone was 34,410 t (16.73% of the trawl net catches) for an effort of 1,48,741 fishing hours with catch rate of 16.7 kg h^{-1}. The catches along with catch rates were significantly higher during the post-monsoon months. *Trichiurus lepturus* was the sole species with size ranging from 54 to 119 cm (mean 70 cm and mode 70 cm) having a sex ratio of 1.35 with equal distribution of mature (57%) and immature females (43%) occurring throughout the year. Relative fecundity per gram body weight of 238.2 and ova diameter of 0.15 to 1.88 mm was recorded in the females of *T. lepturus*. The principal food components were *Acetes*, ribbonfishes, cephalopods and juveniles of sciaenids.

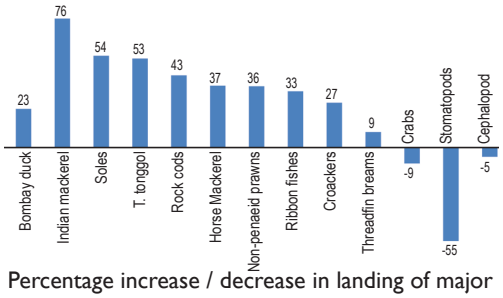
Tunas: The annual catch of tuna in Gujarat during 2011 was estimated at 13,968 t. registering a growth of nearly 37% over the previous year.

Outboard gillnetters (37.3%) and mechanised multiday gillnetters (38%) and multiday trawlers (24.3%) were the major contributors to the landing. The tuna landing in multiday trawlers were exclusively of *E. affinis*. Tunas formed 7% of the landings of pelagic resources. The tuna landings by gillnets at Veraval was 2822.5 t with catch rate of 133 kg unit^{-1}. Nearly 41% of the gillnet catches at Veraval was contributed by tunas. The dominant species landed were *Thunnus tonggol* (51%), *Euthynnus affinis* (38%), *Auxis thazard* (1.3%), *Katsuwonus pelamis* (7.1%), *Thunnus albacares* and *Sarda orientalis* (2%). The length ranges recorded for *T. tonggol, E. affinis* and *K. pelamis* were 380-719 mm, 360-639 mm and 340 to 569 mm, respectively with mean lengths of 528.3 mm, 495.7 mm and 494.4 mm, respectively. Females outnumbered the males in *T. tonggol, E. affinis* and *K. pelamis* in most of the months during 2011. Relative fecundity of *E. affinis* and *K. pelamis* were 168.85 and 136.2 per gram body weight and the ova diameters were 0.2-1.05 mm in *E. affinis* and 0.15-0.85 mm in *K. pelamis*. Clupeoids, squilla, mackerel, cephalopods, tunas, carangids, digested fish and shrimps were the principal food constituents of tunas.



Marine fish landing trend in Gujarat during 2001-2011

Carangids: The annual estimated landings of carangids in Gujarat during 2011 was 20,245 t which formed 3.2% of the total marine fish landings of Gujarat and 9.9% of the total pelagic resources. Multiday trawlers (59.5%) and outboard gillnetters (26%) contributed maximum to the carangid landings in Gujarat. The carangid landings by trawlers and gillnetters in Veraval were 3,617 t and 497 t respectively with an average catch rate of 1.8 kg h^{-1} for trawls and 23.5 kg h^{-1} for gillnets. Among carangids, *Megalaspis cordyla* (48.3%) dominated the gillnet catches, while *Decapterus russelli* (80.5%) dominated the trawl landings. The size range recorded for *M. cordyla* was 210-559 mm with a mean size of 315.6 mm and a dominant size mode occurring at 303 mm. The number of females in the catch of *M. cordyla* were higher (sex ratio: 1:1.3) with 50% of them being immature. The IRI values showed that digested fish and crustaceans along with cephalopods, *Acetes* spp. and fish juveniles were the major food items in the stomach of *M. cordyla*.

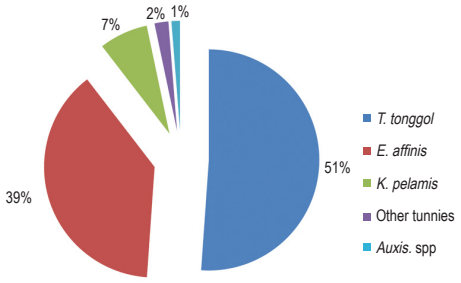


Percentage increase / decrease in landing of major fishery resources over the previous year

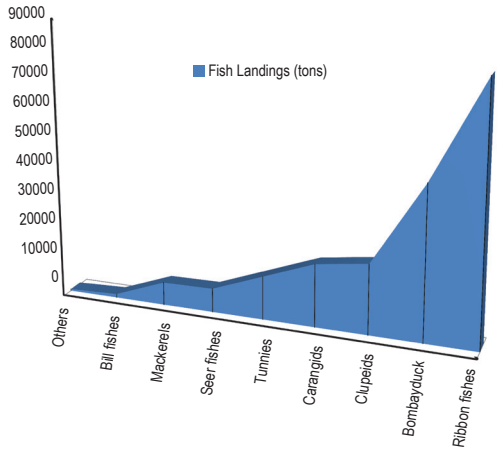
Indian mackerel: The estimated mackerel landings in Gujarat during 2011 was 7,407 t showing a rocketing increase of 72.3% over the previous year. Mackerel formed 3.6% of the total pelagic resources landed in Gujarat during the year. Outboard gillnetters (86%) and mechanised multiday trawlers (12%) contributed the major share of mackerel landings. The trawlers and gillnetters at Veraval landed 229 t and 647 t, respectively of mackerel, with an average catch rate of 0.11 kg h^{-1} for trawls and 30.56 kg unit^{-1} for gillnets. The catches along with catch rates in gillnet was higher in October-November and were significantly higher during the post-monsoon months.

Length ranges and reproductive biology of major pelagic species in Gujarat

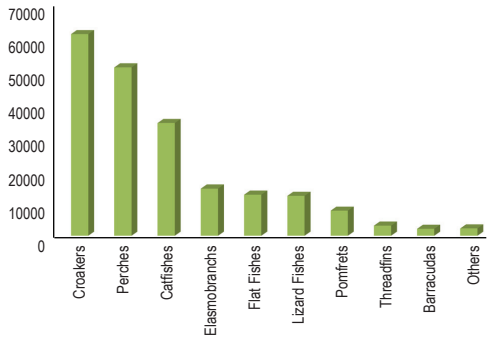
Species	Length range (mm)	Mean length (mm)	Sex ratio	Mature %
Trichiurus lepturus	460-1179	729.0	01:01.4	40.4
Harpadon nehereus	136-257	202.0	01:01.1	19.2
Thunnus tonggol	400-719	528.3	01:06.8	18.0
Euthynnus affinis	340-639	495.7	01:01.8	31.0
Katsuwonus pelamis	340-678	494.4	01:02.5	35.2
Rastrelliger kanagurta	110-299	233.0	01:00.9	43.2
	210-559	315.6	01:01.3	28.0



Percentage contribution of different tuna species in Gujarat



Components of pelagic fishery of Gujarat during 2011



Components of demersal fishery of Gujarat during 2011

Rastrelliger kanagurta was the sole species with size ranging from 110 - 289 mm (mean 233 mm and mode 234 mm) having an average sex ratio of 0.6 during the year with mature (60%) and immature (37%) females occurring throughout the year.

Demersal resources

Threadfin breams: Total threadfin bream landings in Gujarat was 29,019 t during the year 2011, which was 10.32% higher compared to the previous year. The catch was mainly exploited by multiday trawlers (97.86%) followed by single day trawlers (2.13 %) at a catch rate of 0.42 kg h^{-1} and 1.33 kg h^{-1} respectively. The fishery was dominated by *Nemipterus japonicus* (55.77%), *N. randalli* (40.6%), and *N. bipunctatus* (3.6%) in small quantities at Veraval. The length of *N. japonicus* landed ranged between 110 and 290 mm (mean 187.55 mm) with a distinct mode at 184.5 mm, and the length of *N. randalli* was between 90 and 230 mm (mean 130.5 mm) with a distinct mode at 117.5 mm. Immature individuals were represented in higher numbers in *N. randalli* landed while in *N. japonicus* majority were in mature condition. Analysis of food components revealed an abundance of non-penaeid and penaeid prawns as major food items like *Solenocera*, *Acetes, Loligo,* crabs, *Squilla, Chirocentrus* and *Leiognathus* spp. in both the species.

Lizardfishes: Estimated lizardfish landings in Gujarat coast was 12,079 t during the year 2011 which is 4.88% less compared to the previous year. The catch was mainly exploited by multiday trawlers (97.05%) at a catch rate of 0.17 kg h^{-1}. The catch rate was moderately high during the post-monsoon season with relatively higher catch observed during November. Two main species contributing to the fishery were *S. tumbil* (68.33%) followed by *S. undosquamis* (31.67%) at Veraval. *S. tumbil* was in the length range of 100-390 mm (mean length 220.9 mm) with a mode at 198.44 mm. *S. undosquamis* was in the length range of 140-390 mm (mean 134.41 mm) with a mode at 112.5 mm. Gut content analysis of both the species were mostly represented by fishes, shrimp, *Stolephorus*, crabs and cephalopods.

Sciaenids: The Sciaenid landings in Gujarat coast was 61,018 t during the year 2011, marking an increase of 36.30% over the previous year. The catch was mainly exploited by multiday trawlers (49.72%) and outboard gillnetters (17.59%) at a catch rate of 0.45 kg h^{-1} and 3.91 kg h^{-1} respectively. At Veraval, the species composition in trawl fishery was *Otolithes cuvieri* (43.39%), *Johnius glaucus* (27.28%), *Johnieops* sp. (15.66%), *Otolithoides biauritus* (4.57%) and *Protonibea diacanthus* (0.74%). Though the species composition in the gillnet and dolnet represented the same pattern as in trawlers, the percentage of *O. biauritus* and *P. diacanthus* was comparatively higher. Length of *O. cuvieri* ranged from 120 to 320 mm (mean 217.77 mm) with a mode at 207.35mm while for *J. glaucus*, the length range was 110 - 310 mm (mean 196.3 mm) with a mode at 195.61 mm. Sex ratio of 1.99 and 1.44 were recorded for *O. cuvieri* and *J. glaucus* with majority in mature and gravid condition respectively. The important food items recorded in the gut of *O. cuvieri* and *J. glaucus* were non-penaeid prawns such as shrimps, *Acetes* and crabs, among fishes like *Coilia*, ribbonfish, *Secutor, Bregmaceros,* and *Cynoglossus* and Molluscs *Sepia* and *Loligo* juveniles.

Bull's eye: The landings of *Priacanthus hamrur* by trawlers was 2,065 t at a catch rate of 1 kg h^{-1} which formed 1.39% of the total landings at Veraval. The catch rate declined to 7.56% while comparing with the previous year. The length of *P. hamrur* caught by trawlers ranged between 140-380 mm (mean 206.58 mm) with a mode at 191.43 mm. Sex ratio of 1.5 was recorded and immature (24.85%), mature (31.53%) and gravid/spent (33.61%) individuals

were represented throughout the year. The analysis of gut revealed presence of non-penaeid prawns such as shrimp, *Acetes* spp. and among fishes, *Saurida, Thryssa,* eel and *Nemipterus* and *Sepia* and *Loligo* among cephalopods.

Pomfrets: Total pomfret landing in the Gujarat coast was 7,594 t during 2011, which increased by 1.06% compared to previous year. Species contributing to the fishery were silver pomfret (75.23%), black pomfret (18.47 %) and Chinese pomfret (2.29%). The catch was mainly exploited by multiday trawls (51.44%) followed by mechanised gillnets (19.39%) and mechanised dolnets (18.82%). The total pomfret landings by trawlers were 277.1 t with a catch rate of 0.13 kg h^{-1} which formed 0.19% of the total trawl catches at Veraval. The gillnet production was 123.9 t with a catch rate of 5.89 kg $unit^{-1}$. The length ranged between 160-330 mm (mean 206.12 mm) with a mode at 191.43 mm. Gonadal studies revealed presence of mature (35.78%), immature (34.56%), gravid and spent (9.65%) ones in the population. The gut analysis showed that almost all the fishes were in the empty condition and the food items such as *Acetes*, shrimps and fishes were recorded in few specimens only.

Silver pomfret landed by trawlers in Nawabunder

Catfish: Total catfish landings along Gujarat coast was 34,120 t during 2011, showing an increase of 3.16% compared to the previous year. The catch was mainly exploited by mechanised dolnets (36.68%) and multiday trawlers (36.30%) at a catch rate 10.10 kg h^{-1} and 0.18 kg h^{-1} respectively. The estimated catch of catfish by trawlers at Veraval was 3,014 t with a catch rate of 1.46 kg which formed 2.03% of the total trawl catches at Veraval. The length range of *Arius tenuispinis* was 210 - 640 mm (mean: 279.44 mm) with a mode at 244.06 mm. The sex ratio (1:1.4) showed that the females were dominant in all the months with the occurrence of immature and mature ones in the landing. The gut analysis revealed that the food components of catfish were *Acetes,* shrimps, *Squilla, Nemipterus,* sciaenids and *Loligo,* along with gastropod shells and remnants of opercula.

Women and children sorting catch from a dolnetter at Jaffarabad Harbour

Flatfishes: Total sole landings in Gujarat was 12,032 t during the year 2011. The catch was mainly exploited by multiday trawlers (65.33%) followed by mechanised dolnets (17.56%) at a catch rate of 0.11 kg h^{-1} and 1.72 kg $unit^{-1}$ respectively.

Elasmobranchs: Elasmobranch landings in Gujarat was 12,382 t during the year 2011 which recorded an increase by 43.29% compared to the previous year. Group-wise landings of elasmobranchs were sharks (63.76%), rays (25.76%) and skates (10.46%). The catch was mainly exploited by multiday trawls

Length ranges and reproductive biology of demersal species in Gujarat

Species	Length range (mm)	Mean length (mm)	Sex ratio	Mature %
Nemipterus randalli	90-230	130.5	1.03	41.98
Nemipterus japonicus	110-290	187.55	1.19	22.37
Saurida tumbil	100-390	220.90	1.93	18.09
Saurida undosquamis	140-390	134.41	0.76	8.19
Priacanthus hamrur	140-380	206.58	1.50	31.53
Johnius glaucus	110-310	196.30	1.44	31.75
Otolithes cuvieri	120-320	217.77	1.99	27.81
Pampus argenteus	160-330	206.12	1.22	35.78
Scoliodon laticaudus	330-650	400.40	4.40	14.43
Arius tenuispinis	210-640	279.44	1.44	17.93

Catfish (*Arius tenuispinis*) landing in Vanakbara, Diu

(53.55%) at a catch rate of 0.028 kg h^{-1}. The total elasmobranch landings by trawlers was 810.6 t with a catch rate of 0.39 kg which formed 0.54% of the total trawl catches of Veraval. The gillnet production was 266.2 t with a catch rate of 12.65 kg $unit^{-1}$. The dominant species in the trawl fishery was *Scoliodon laticaudus* (48.80%), *Mobula* sp. (1.70%), *Carcharhinus* sp. (8.07%), *Rhinobatos* sp. (20.59%), *Mustelus mosis* (1.69%) and *Dasyatis* sp. (19.15%) and in gillnet fishery, *Scoliodon* 63.44%, *Carcharhinus* 31.04%, *Dasyatis* sp. 3.82% and *Mobula* 1% were the important contributors. The length of *S. laticaudus* ranged from 330-650 mm (mean 400.40 mm) with a mode at 392.88 mm. Sex ratio of 4.40 was recorded and immature individuals were found to be dominant in the population. The important food items recorded were shrimp *Acetes, Squilla,* ribbonfish, Bombayduck, *Thryssa, Coilia, Sepia* and *Loligo* spp.

Cephalopod landings at Gujarat

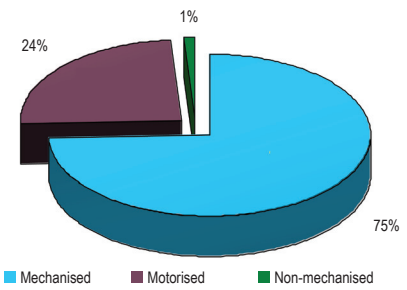
Crustaceans resources

Total crustacean landings in Gujarat was 1,52,312 t during 2011, which registered an increase by 34.85% compared to the previous year. Gear-wise landings indicate that mechanised dolnetters (MDOL), contributed 60.45% of total crustacean landings followed by mechanised multiday trawlers (MDTN-30.94%), single day trawlers (MTN- 7.84%) and other gears 0.76%. Among the crusteceans, major group caught in Gujarat region is the non-penaeid prawns (70.63%) followed by penaeid prawns (15.71%), crabs (11.81%), stomatopods (1.67%) and lobsters (0.16%). The major shrimp species landed in Gujarat are *Solenocera crassicornis, Metapenaeus monoceros, Fenneropenaeus merguiensis, Penaeus monodon, F. indicus, M. brevicornis, Parapenaeopsis sculptilis, P. hardwickii* and *Acetes* spp. The crabs include *Charybdis ferriata, Portunus pelagicus*, and *P. sanguinolentus*. The lobsters were mainly *Panulirus polyphagus* and *Oratosquilla nepa* (squilla) was the stomatopod species landed.

Molluscan resources

Cephalopods: Total molluscan landings in Gujarat t was 51,564 t during the year 2011, which registered a decrease by 5.13% compared to the previous year. Squid constituted the major landings (52.76%) followed by cuttlefish (15.68%) and octopus (0.16%). Estimated cephalopod landings in Veraval during the year was 22,261.2 t. The major species among cephalopods landed by multiday trawlers at Veraval Landing Centre was *Loligo duvaucelli.*

Tamil Nadu and Puducherry



Sector-wise contribution to marine fish landings in Tamil Nadu during 2011

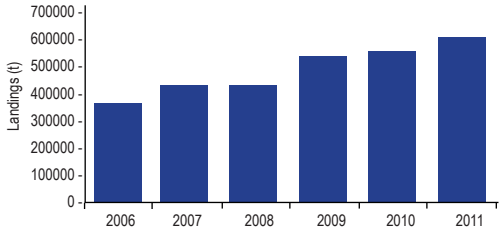
Tamil Nadu

Annual marine fish landings in Tamil Nadu increased to 6,30,299 t during the year 2011. Maximum production was recorded in June, when the landings were > 93,000 t. Marine fish production in Tamil Nadu has seen a considerable increase over the last six years. The increase in 2011 has been to the tune of 63% from the landings in 2006. The catch has been steadily increasing over the last three years, crossing 5 lakh t in 2009, 5.5 lakh t in 2010 and 6 lakh t in 2011.

The mechanised and the motorised sectors contributed 75% and 24% of the total landings respectively, while the non-mechanised sector contributed only 1%. While the motorised sector formed more than 50% of the landings in 2006 and 2007, it has now been superceded by the mechanised sector, except during the trawl ban month of May and the NE Monsoon month of October. Trawl landings formed 63% of the total marine fish landings in the state.

Fishes formed more than 85% of the monthly landings, crustaceans formed 6% and molluscs 5%. Among the fishes, pelagics dominated the landings, forming 63% of the total landings while demersals formed 25%.

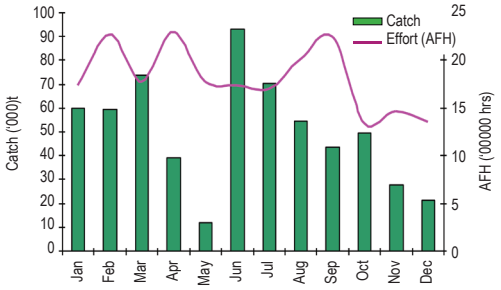
Clupeids formed about 39.6% of the total landings during the year and carangids formed 11%, followed by silverbellies (9.2%), perches (6.9%), Indian mackerel (4.4%). Tunas, elasmobranchs, croakers, barracudas, lizardfishes and goatfishes each formed 1-2% while catfishes, mullets, seerfishes, half beaks/ full beaks, flatfishes, pomfrets, flying fishes, threadfins, billfishes, eels and big jawed jumper each formed less than 1%. Clupeids continued to dominate the landings in 2011 also, with a spurt in the landings of oil sardine, which has increased significantly from less than 10000 t in 1985 to > 1,35,000 t in 2011. Oil sardine formed 55% of the clupeid catch; silverbellies and lesser sardines were landed to the tune of 54,835 t and 57,659 t respectively. Carangids formed the next largest group contributing to the marine fish landings along the TN coast, followed by silverbellies. The landings of clupeids, carangids, silverbellies and ribbonfishes have increased from 2010. Perches and elasmobranchs also showed marginal improvement. Cephalopods, shrimps, tunas, crabs, barracudas and goatfishes are some of the major resources that have shown a decline in landings from the previosus year.



Annual marine fish landings (tonnes) in Tamil Nadu during 2006-2011

Pelagic fishery resources

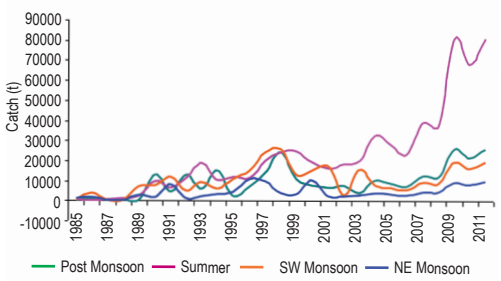
Sardines: About 1,98,001 t of sardines were landed along the Tamil Nadu coast during the year 2011, by various gears. The oil sardine *Sardinella longiceps* dominated the fishery, forming 72.3% of the sardine production. Mechanised trawl nets and mechanised ring seines landed 61,239 t and 51,187 t of *S. longiceps*, respectively. Mechaised trawlers and outboard gillnetters accounted for 31,391 t and 13,052 t of lesser sardines, respectively. The lesser sardine landings by trawl nets were dominated by *S. gibbosa, S. sirm* and *S. clupeiodes*. *S. gibbosa* formed nearly 85% of the landings by chala/kavala valai.



Monthly catch and effort (AFH) for marine fish landings in Tamil Nadu (all gears) during 2011

Mackerel: About 27,761 t of mackerel was landed along the Tamil Nadu coast in 2011, with gillnets contributing 61%, trawl nets 31.2%, and ring seines 6.2%. The landings were made up of a single species, *Rastrelliger kanagurta*. The trawl net landing of mackerel at Chennai showed a considerable increase of 182.5% from the previous year

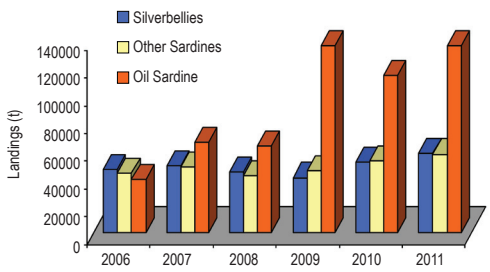
Whitebaits: About 21,108 t of whitebaits was landed along the Tamil Nadu coast in 2011, outboard gillnetters landed 83% while trawl nets landed 11.2%. *Stolephorus indicus* dominated the whitebait catch along the coast. *S. commersoni* (18.5%) and *S. bataviensis* (12.5%) were the other dominant species in the catches along north Tamil Nadu coast while in the south, *S. waitei* and *S. devisi* were predominant in addition to *S. indicus*.



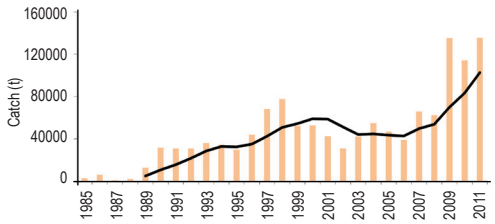
Seasonal catch trend of oil sardine landed along Tamil Nadu coast (1985-2011)

Population parameters of major pelagic resources of Tamil Nadu

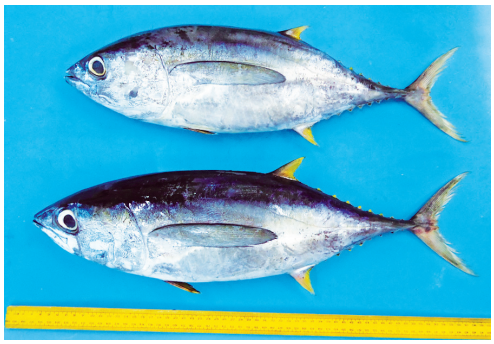
Species	L∞(cm)	Ky-1	Lm (cm)	Lc (cm)	M	F	Z
S. gibbosa	18.8	1.24	12.2	13.4	2.38	5.63	8.01
R. kanagurta	31.5	1.2	18.6	21.8	2.02	2.57	4.59
S. indicus	16.3	1.8	12.5	11.6	3.16	0.67	3.83
T. albacares	159.25	0.51	81	56	0.73	1.18	1.9
K. pelamis	77.7	0.88	43	39	1.28	1.87	3.15
E. affinis	73.7	1.3	44	39.8	1.67	2.3	3.98
S. commerson	150	0.65	-	66	0.874	1.35	2.22



Major contributors to marine fish landings in Tamil Nadu (2006-2011)



Oil sardine landings along Tamil Nadu coast (1985-2011) with trend line of 5 yearly moving average



Juveniles of yellowfin tuna landed at Chennai

Seerfish: About 4641 t of seerfish was landed in 2011. Of this, 55% was landed by gillnets, 26.4% by trawl net, and 10.6% by hooks & lines. The landing by all the gears was dominated by *Scomebromorus commerson*, forming 93.3% of the total seerfish landings; *S. guttatus* 6% and *Acanthocybium solandri*, 0.7%.

Tunas: About 13078 t of tunas were landed in the year 2011, with gillnets contributing 51.5% and seines contributing 41.8%. Hook & lines accounted for 1.2% and trawl nets, 0.9%. *Euthynnus affinis* formed 57% of the tuna landings, followed by *Auxis spp.* (13.2%), skipjack tuna and *Katsuwonus pelamis* (10.3%).

Ribbonfishes: An estimated 17245 t of ribbonfish was landed along Tamil Nadu coast in 2011. About 79.4% t was landed by trawl net and 20.5% by gillnets. The catch was dominated by *Trichiurus lepturus*.

Carangids: A total of 69181 t of carangids was landed along Tamil Nadu coast during 2011. Of this, trawl net contributed 85.9%, gill net, 7.2%, seines 3.1% and hooks & lines 2.3%. Scads formed 72.1%, trevallies and leather jackets together formed about 27%. *Selar crumenophthalmus*, *Decapterus russelli, Caranx ignobilis* and *C. sexfasciatus* were predominant in the landings.

Demersal resources

Elasmobranchs: Elasmobranchs contributed to 2%, 3.3%, and 2.1% of the total marine fish catch landed in Tamil Nadu by trawl nets, mechanised gillnets, and hook and line units, respectively. Out of an estimated 12281 t of elasmobranchs, 63.2% was accounted for by trawl nets, 32.2% by gillnets and 4.2% by hooks & lines. Rays contributed maximum to the elasmobranch catches by all gears, forming 89.8%. Sharks formed 6% of the elasmobranch landings and skates, 4.2%. The dominant species in the trawl net catches were *Himantura jenkinsii* and *Gymnura poecilura* (among rays), *Scoliodon laticaudus*, *Carcharhinus sorrah, Rhizoprionodon acutus* and *Sphyrna lewinii* (among sharks) and *Rhina ancylostoma* (among guitarfishes). The dominant species in the gillnet catches was *Carcharhinus leucas* (among sharks), *Mobula diabolus* and *H. jenkinsii* (among rays). About 50% of the landing of rays was contributed by *M. diabolus*.

Threadfin breams: About 13,487 t of threadfin breams were landed, contributing to about 2.1% of the total marine fish landing of the state in the year 2011. Of this 96.7% (13,043 t) was landed by trawl nets, accounting for 3.4% of the total trawl landings during the period. *Nemipterus randalli, N. japonicus, N. bipunctatus*, and *N. peronii* were the major species in the trawl landings, with *N. japonicus* and *N. randalli* together accounting for almost 65% of the threadfin bream landing.

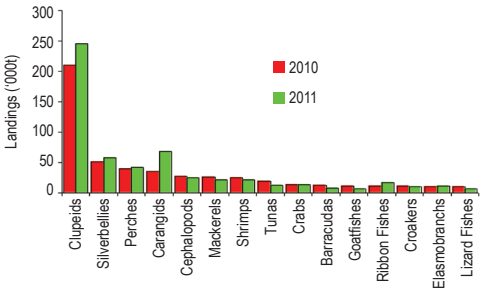
Lizardfishes: Lizardfishes formed only 1.1% of the total marine fish landings and 1.7% of the total trawl landings in Tamil Nadu in 2011. A total of 6981t of lizardfishes were landed, of which 6558 t were landed by trawl nets. *Saurida undosquamis* and *S. tumbil* dominated the catch. Other species that occurred included *S. micropectoralis, S. longimanus* and *Trachynocephalus myops*.

Sciaenids: At Chennai, about 9729 t of sciaenids was landed in 2011, forming 1.5 % of the total catch. Trawl nets accounted for 61.4% of the sciaenid catch and gillnets accounted for 33%. *Otolithes ruber* (28%) dominated the catch, followed by *Johnius carutta* (16%) and *Nibea maculata* (13.2%).

Silverbellies: About 57659 t of silverbellies were landed in Tamil Nadu during 2011, forming about 9.2% of the total landing. Trawl nets accounted for 93.8% of the landings of silverbellies. *Leiognathus splendens* and *L. dussumieri* dominated the landings followed by *L. equulus* and *Gazza minuta*.

Goatfishes: During 2011, goatfish landing along Tamil Nadu coast was 7149t, of which 82.9% was landed by trawl nets. Goatfish constituted 1.1% of the marine fish landing in the state during 2011. The dominant species was *Upeneus sundaicus* (35%), followed by *U. taeniopterus* (23%), *U. moluccensis* (19%). *U. bensasi* (10%) and *U. sulphureus* (5%). *Upeneus vittatus, Parupeneus cinnabarinus* and *P. indicus* were also found to occur in the landings.

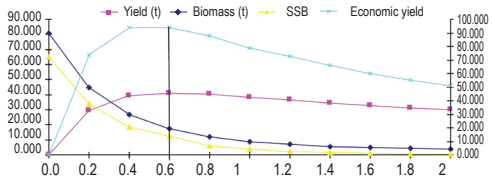
The trend at Chennai (Kasimedu Fisheries Harbour) reveals a decline in the landings of the demersal finfish assemblage. There has been a decrease in the AFH at Chennai while the CPUE for demersals has shown an improvement from 1985 to 2011. The MSY for demersals estimated by surplus production model (Schaeffer Model) was about 12,000 t while the annual average landing during the period was 8300 t. The exploitation rate of many dominant fishes remains below or near optimum, in the range of 0.26-0.55. Spawning stock biomass of many of the exploited stocks is near to or more than 50-65% of the standing stock biomass.



Landing of major marine resources in Tamil Nadu during the years 2010 and 2011

Crustacean resources

Prawns: About 20,163 t of penaeid prawns were landed, accounting for 54.8% of the crustacean landings in Tamil Nadu in 2011. About 85.4% of this was landed by trawl nets. The catch of non-penaeid prawns was relatively meager, accounting for 3.4% of the prawn landings. Prawn fishery along south Tamil Nadu coast (off Tuticorin) is done by mechanised trawl, indigenous trawl and gillnet (mainly in the estuarine areas). Mechanised trawls landed 119 t of prawns from inshore waters and 468 t of deep sea prawns. The main fishing season was June to August for prawns in the inshore areas and November to April for deep sea prawns. Indigenous trawl landed 46t of prawns while gillnets landed 13t. There was no regular gillnet fishery for prawns. The prawns were landed as bycatch of sardine fishery. Inshore prawns comprised of 25 species, of which the dominant ones brought in by mechanised trawl were *Penaeus semisulcatus* (72%), *Fenneropenaeus indicus* (99%), *P. latisulcatus* (7%), *Parapenaeopsis maxillipedo* (3.7%), *P. uncta* (2.9%) and *Metapenaeus dobsoni* (2.7%). Twelve species were recorded in the indigenous trawl landings, dominated by *P. semisulcatus* (89%), *P. maxillipedo* (2.1%), *M. moyebi* (2.1%), *F. indicus* (0.4%) and *M. stridulans* (0.4%). Deep sea prawns were dominated by *Plesionika spinipes* (34%), *H. gibbosus* (30%), *Solenocera hextii* (28%), *Aristeus alcocki* (4.5%) and *Heterocarpus woodmasoni* (1.5%). Other species of deep sea prawns observed during the period were *P. fissuroides, P. indica, P. jerryi, P. martia, M. andamanensis, S. alphonso* and *P. investigatoris*.



Prediction analysis - *P. semisulcatus* (male+female)

Stock assessment of *P. semisulcatus* was done based on the data collected from thallumadi, the gear which operated throughout the year along this coast. The fishing mortality on males has to be reduced by 40% to obtain the maximum sustainable yield (MSY). But to sustain the fishery at maximum profitable level (at MEY) the fishing mortality has to be reduced again by 20%. In the case of females also the fishing mortality has to be reduced by 40% to obtain MSY and MSE. When the males and females were pooled the MSY and MSE are at f-factor 0.6.

Crabs: About 14,136 t of crabs were landed in Tamil Nadi in 2011, forming 2.2% of the total marine fish landing and 3.4% of the crustacean landings. About 48.1% of the crab landings were by gillnets and 40.2% by trawl nets. At Tuticorin, a total 1559 t of crabs were recorded of which 1397 t was landed by mechanised trawl net at Tuticorin, 48 t was landed by indigenous trawl at Motaguparam, 48 t was landed by gillnet (marine sector) at Tharuvaikulam and 66 t was landed by gillnet (estuarine sector) at Punnakayal. Twelve species of crabs were recorded in the mechanised trawl catch of which the dominant ones were *Charybdis natator* (83%), *P. haanii* (8.7%), *P. sanguinolentus*

Population parameters and size at maturity of crabs landed in Tamil Nadu

Species	Sex	L_∞	K	M
P. haanii	M	103	1.3	2.1
	F	96	1.1	1.3
P. pelagicus	M	169	1.7	2.5
	F	170	1.4	1.5
C. natator	M	124	1.4	2.6
	F	112	1.6	2.6
P. sanguinolentus	M	182	1.2	2.5
	F	170	1.5	1.9

Solenocera alphonso
(first record from Indian coast)

(7%), *C. smithi* (90.9%), *P. pelagicus* (0.4%) and *P. gladiator* (0.2%). The catches by indigenous trawl were dominated by *P. pelagicus* (42%), *P. sanguinolentus* (29.6%), *C. natator* (24.9%) and *C. annulata* (1.4%). Fourteen species were recorded in the gillnet catches at Tharuvaikulam, dominated by *C. natator* (34.7%), *P. sanguinolentus* (28.3%), *P. haanii* (18.2%), *P. pelagicus* (11.1%), *C. luicifera* (1.5%) and *C. helleri* (1.2%). At Punnakayal, the catches were dominated by *P. sanguinolentus* (43%), *P. pelagicus* (18%), *C. natator* (15%), *P. haanii* (13%), *Scylla* sp. (8%) and *C. lucifera* (1%).

Lobsters: Only 187 t of lobsters were landed in Tamil Nadu in 2011, forming 0.5% of the crustacean landings and 0.03% of the total marine fish landings. The dominant species was *Panulirus homarus* (47%) followed by *P. ornatus* (43%) and *P. versicolor* (10%).

Molluscan resources

About 30299 t of molluscs were landed in Tamil Nadu in the year 2011. Squids formed 47.9%, cuttlefish 30.7%, bivalves 9.7%, octopus 6.8% and gastropods 4.8%. *Sepia pharaonis, S. lessoniana, Loligo duvaucelii* and *L. edulis* were the dominant species.

Puducherry

The annual trawl landing at Puducherry harbor in 2011 was 6,550 t with effort expended being 96077 units and 352931 hours. The annual CPH was 18.56 kg. Pelagic finfish contributed 60.8% of the average annual landings, while Demersal finfish formed 23.5%, crustaceans formed 8.8% and molluscs formed 4.7%. Low value by-catch formed 2.2 % of the landings. Trawl boats accounted for 39.4% of the total catch. The mechanised sector accounted for 41.4% of the total landings, motorised sector 58.4% and non-mechanised sector 0.2%.

Solenocera koelbeli
(first record from east coast of India)

The landings comprised commercial varieties of prawns, lobsters, cuttlefish and fishes like threadfin breams, sardines, mackerel, goatfishes, lizardfishes, perches and croakers. Silverbellies, large perches, croakers, threadfin breams, goatfishes, catfishes and elasmobranchs were the dominant groups among the demersal resources. Among the pelagic resources, Indian oil sardine was the single largest contributor, forming 44.3% of the pelagic finfish catch and 27% of the total landings. The Indian mackerel formed 16.4% of the pelagic catch and 10% of the total landings at Puducherry. Carangids and ribbonfishes were the major contributors to the landings. The crustacean landings were formed by penaeid prawns and crabs. Non-penaeid prawns, lobsters and stomatopods were not recorded in the landing. Among the molluscs, squids formed about 57.8% and cuttlefish formed 42.2%.

Andhra Pradesh

The total marine fish production of Andhra Pradesh during 2011 was 2.75 lakh t. Pelagic resources accounted for 1.6 lakh t (58.3%), followed by demersal resources 0.73 lakh t (26.6%), crustaceans 0.34 lakh t (12.3%) and cephalopods 0.036 lakh t (1.31%). The dominant pelagic groups landed were clupeids (0.68 lakh t and 42.25%), mackerels (0.22 lakh t and 14%), tunas and billfishes (0.22 lakh t and 13.88%), carangids (0.17 lakh t and 10.53%), ribbonfishes (0.15 lakh t and 9.52%) and seerfishes (0.06 lakh t and 3.47%). The major groups that contributed to demersal landings were sciaenids (18.4%), perches (18.4%), pomfrets (13.2%), goatfishes (9.2%), catfishes (9.2%) and elasmobranchs (11.0%). Penaeid prawns dominated with an annual landing of 0.26 lakh t forming 78% of the crustacean resources. Crabs with an annual catch of

0.057 lakh t (17%) and non-penaeid prawns with 0.01 lakh t (3%) were the other notable contributors to the crustacean catch. Cuttlefish landings were estimated at 0.024 lakh t, and squid 0.012 lakh t.

Catch of major finfish and shellfish resources of Andhra Pradesh

Group	Catch (t) in 2011	Catch (t) in 2010	Increase (+) / Decrease (-) %
Clupeids	67697	75789	-10.7
Mackerels	22401	17331	29.3
Ribbonfishes	15252	11432	33.4
Carangids	16873	14179	19
Tunas	18614	8458	120.1
Seerfishes	5559	7068	-21.3
Barracudas	4332	2088	107.5
Billfishes	3624	1037	249.5
Threadfin breams	5027	5336	-5.8
Sciaenids	13488	9264	45.6
Lizardfishes	4539	4956	-8.4
Goatfishes	6735	7352	-8.4
Sharks	2054	1254	63.8
Rays	5872	4390	33.8
Penaeid prawns	26368	27408	-2.3
Non penaeid prawns	1081	2000	-46
Crabs	5703	6281	-5
Cuttlefishes	2380	3020	-21.2
Squids	1209	837	44.4

Bulk landings of lesser sardines at Visakhapatnam

Pelagic resources

Among clupeids, the major contributors were lesser sardines (0.34 lakh t), oil sardine (0.12 lakh t) and *Stolephorus* (0.05 lakh t). Carangid landings were contributed by horse mackerel (21.8%), scads (22.4%), leatherjackets (8.8%) and others (47.1%). The mackerel landings were contributed solely by *Rastrelliger kanagurta*. Trawl catch was composed chiefly of lesser sardines (44.6%), rainbow sardine (31.9%) and oil sardine (23.5%). In silk nets (33 mm mesh size), the catch was 619 t with a catch rate of 175 kg unit^{-1} forming 98.7% of the total catch. The silk net catch was dominated by lesser sardines (69.2%), oil sardine (18.7%) and rainbow sardine (12.1%).

Seerfish catch was dominated by *Scomberomorus commerson* (59.4%) and *Scomberomorus guttatus* (40.6%). Among tunas, the dominant species were *Thunnus albacares* (34.1%), followed by *Euthynnus affinis* (28.8%), *Katsuwonus pelamis* (28%) and *Auxis thazard* (9.1%). The landings of billfishes and barracudas for the year were 0.04 lakh t each.

Seerfish landed at Visakhapatnam

The mackerel landings by trawlers and gillnetters (55 mm mesh size) in Visakhapatnam were 7,832 t and 636 t, respectively with an average catch rate of 3.1 kg h^{-1} for former and 53.1 kg unit^{-1} for the latter. About half (49%) of the gillnet catches at Visakhapatnam were contributed by mackerel. However in trawlnet catches, the contribution of mackerel was 11.2%. More than 99% of the trawl catches and gillnet catches were composed of *Rastrelliger kanagurta* and the rest by *Rastrelliger faughnii*.

The ribbonfish landing by trawlers at Visakhapatnam was 4,316 t (6.15% of the trawl net catches) with the catch rate of 1.71 kg h^{-1}. The catches

along with catch rates were significantly higher during August-September. The seerfish landing by trawlers at Visakhapatnam was 412 t with catch rate of 0.16 kg h^{-1}. *Scomberomorus guttatus* dominated the gillnet landings while the trawl fishery was supported by both *Scomberomorus guttatus* and *Scomberomorus commerson*.

The annual catch of tuna recorded by hooks and lines at Visakhapatnam was 2714 t with the catch rate of 42.3 kg $unit^{-1}$. About 43.4% of the hooks and line catches at Visakhapatnam was contributed by tuna alone. The dominant species landed in hooks and lines were *Thunnus albacares* (53%), *Katsuwonus pelamis* (31%) and *Euthynnus affinis* (16%). In gillnetters at Visakhapatnam, the annual catch was 675 t, at a catch rate of 35 kg $unit^{-1}$ forming a quarter of the total gillnet catches. One third of the gillnet catches was constituted by *Thunnus albacares*. The annual catch of tuna by hooks and lines at Pudimadaka was 397 t with a catch rate of 14.2 kg $unit^{-1}$ forming 46% of the total hooks and line catches. The dominant tuna species was *Thunnus albacares* contributing 59% to the total tuna catch. The annual hooks and line catches of tuna at Kakinada (Dummulapeta and Bhairavapalem) amounted to 3,363 t at a catch rate of 126.1 kg $unit^{-1}$. Tunas formed 35.4% of the total hooks and line catches at Kakinada. The major contributor to the tuna fishery at Kakinada was *Thunnus albacares* (37.2%).

Yellowfin tuna landed at Visakhapatnam Fishing Harbour

Demersal resources

About 0.08 lakh t of elasmobranchs were landed of which 25.6% were sharks, 1.3% skates and 73.1% rays. Sharks were mainly caught by hooks and lines, trawl nets and gillnets. Rays were mainly landed by mechanised trawls. About 0.13 lakh t of sciaenids were landed, majority by mechanised trawls. Of the 0.07 lakh t of goatfishes, more than 90% were landed by mechanised trawls. About 0.05 lakh t of threadfin breams were landed, of which 90% was landed by mechanised trawls. Of the 0.045 lakh t of lizardfishes, 90% were landed by mechanised trawls.

The average catch rate of sciaenids, goatfishes, threadfin breams and lizardfishes in mechanised trawls was 1.71 kg h^{-1}, 1.3 kg h^{-1}, 0.9 kg h^{-1} and 0.9 kg h^{-1}, respectively. The dominant species of sciaenids landed were *Otolithes ruber* (25.4%), *Protonibea diacanthus* (25.3%), *Pennahia macrophthalmus* (10.8%) and *Nibea maculata* (11.7%). The major species of goatfish landed were *Upeneus vittatus* (43.6%), *U. moluccensis* (28.7%) and *U. sulphureus* (27.1%). The major species of threadfin breams landed were *Nemipterus japonicus* (52.4%), *N. randalli* (18.4%), *N. bipunctatus* (12.1%), *N. tolu* (=peroni) (9.5%) and *N. luteus* (7.6%). The major species of lizardfishes landed were *Saurida undosquamis* (57.4%), *S. micropectoralis* (23.3%) and *S. tumbil* (18.9%).

Pomfrets landed at Visakhapatnam

The average catch rate of sharks, rays and skates in mechanised trawls was 0.09 kg h^{-1}, 0.02 kg h^{-1} and 0.8 kg h^{-1} respectively. The most common shark species were *Iago omanensis*, *Sphyrna lewini* and *Chiloscyllium* sp.. The most common ray species landed were *Gymnura poecilura, Himantura jenkinsii, Torpedo marmorata, Aetomylaeus nichofii* and *Aetobatus narinari*.

Crustacean resources

Of the 0.26 lakh t of penaeid prawns, trawlers contributed maximum (85.17%) followed by motorised gillnets (8.0%), non-motorised gillnets (1.69%) and motorised seines (1.68%). About 0.057 t of crabs were landed and major portion was contributed by trawlers (84.6%) followed by motorised gillnets (4.79%), non-motorised gillnets (3.73%) and motorised seines (3.31%). Penaeid prawn catch landed by small trawlers was constituted by about 25 species. *M. monoceros* dominated (31.15%), followed by *M. dobsoni* (18.85%), *Metapenaeiosis barbata* (6.57%), *Solenocera melantho* (6.54%),

S. crassicornis (5.94%), *Parapenaeopsis uncta* (4.8%), *P. coromondalica* (4.32%) and *P. stylifera* (4.23%). About 14 genera/species of penaeid prawns contributed to the catch landed by sona boats. *M. monoceros* dominated (29.9%), followed by *M. dobsoni* (16.74%), *Solenocera* spp. (18.01%), *Metapenaeopsis* spp. (11.38%), *Parapenaeopsis* spp. (10.14%) and *Fenneropenaeus indicus* (3.53%).

Portunus pelagicus landed at Kakkinada

Molluscan resources

The mechanised trawlers contributed entirely (98.9%) to the cephalopod landings. Among cuttlefish, *S. pharaonis* dominated (45.1%) followed by *Sepia aculeata* (42.6%) and *Sepiella inermis* (7.0%). Among squids, *Loligo duvaucelii* was the only species landed. The catch of sardine from the trawl nets at Visakhapatnam was 2,705 t., which formed 3.85% of the trawl net catches with a catch rate of 1.07 kg h^{-1}.

The total bivalve production from Bhimili Estuary was 88.7t. The average catch per unit effort was 48.3 kg. The average monthly catch was 7.4 t. Three species of clams *(Meretrix meretrix, M. casta* and *Anadara* sp.*)* and the oyster

Growth and mortality parameters of finfish and shellfish resources landed at Visakhapatnam

Species	L_∞	W_∞	k	Z	M	F	E	L_c (cm)
Sardinella longiceps	22.5 cm	85 g	1.1	3.38	2.03	1.36	0.4	18.73
Rastrelliger kanagurta	27.4 cm	220 g	0.47	1.89	1.1	0.79	0.42	17.62
Katsuwonus pelamis	68.2 cm	5.72 kg	0.34	1.26	0.69	0.57	0.45	50.58
Thunnus albacares	208.9 cm	150 kg	0.08	0.48	0.2	0.28	0.59	109.8
Trichiurus lepturus	114.4 cm	1.24 kg	0.13	0.74	0.32	0.42	0.57	40.26
Nemipterus japonicus	34.5 cm	513.7 g	0.3	1.87	0.77	1.1	0.59	13.72
Pennahia macrophthalmus	36.0 cm	746.5 g	0.53	3.76	1.1	2.66	0.71	16.30
Upeneus vittatus	23.5 cm	175.6 g	0.33	2.21	0.91	1.3	0.59	12.6
Saurida undosquamis	40.5 cm	496.3 g	0.29	2.51	0.72	1.79	0.71	19.5
Metapenaeus monoceros (males)	18 cm	32.8 g	2.2	13.81	1.79	12.02	0.87	7.98
Metapenaeus monoceros (females)	22.4 cm	79.1 g	1.78	7.03	1.49	5.54	0.79	8.39
Metapenaeus dobsoni (males)	11.9 cm	10 g	1.4	7.62	1.52	6.11	0.8	5.33
Metapenaeus dobsoni (females)	12.5 cm	11.9 g	1.75	7.57	1.73	5.84	0.77	5.56
Portunus sanguinolentus (males)	23 cm	615.5 g	1.4	6.53	1.26	5.27	0.81	7.35
Portunus sanguinolentus (females)	22 cm	508.4 g	1.3	7.82	1.22	6.6	0.84	6.85
Sepia aculeata	24.2 cm	3.2 g	0.4	1.61	0.55	1.058	0.34	8.09
Sepia pharaonis	28.99 cm	5.0 g	0.87	2.86	1.19	1.67	0.42	21.17
Loligo duvaucelii	17.5 cm	6.08 g	0.3	1.20	0.22	0.958	0.2	6.08

Crassostrea madrasensis are exploited from this estuary. *Meretrix casta* landed was 39.98 t, *M. meretrix* 23.9 t, *Anadara* sp. 1.95 t and *C. madrasensis* 47.8 t.

The total bivalves landed from Kakinada Bay were 836.9 t, with an average monthly landing of 72.5 t. The average catch per unit effort was 131.2 kg. The species landed were *Anadara* sp. (276.65 t), *M. meretrix* (72.83 t), *Meretrix casta* (24.71 t), *Paphia malabarica* (14.0 t), *Geloina* sp. (9.3 t), *Katelysia opima* (4.5 t), and others (6.6 t). The total clam production was 401.9 t. *Oysters* landed were windowpane oyster, *Placuna placuna* (383.8 t), edible oyster *Crassostrea madrasensis* (51.2 t) and other oysters (5.8 t).

Meretrix spp. landed at Kakkinada

The total gastropod landings from Kakinada Bay were 328.8 t with average monthly landings of 23.4 t. The average catch per unit effort was 48.6 kg. The species landed were *Cerithidium* sp. (257.7 t), *Telescopium* sp. (23.7 t), *Thais* sp. (15.3 t), *Murex* sp. (10.3 t), *Hemifusus* sp. (9.9 t), *Umbonium* sp. (3.1 t), *Dolostium* sp. (0.3 t) and other gastropods (8.5 t).

Length measurements and reproductive biology of major finfish and shellfish species of Andhra Pradesh

Species	Length range (mm)	Mean length (mm)	Annual Sex ratio	Spawning months	Fecundity	Ova diameter (mm)
Sardinella longiceps	57-214	143.5	1.16	May-Sept	19028-66513	0.21-0.73
Sardinella fimbriata	60-179	127.2				
Sardinella gibbosa	160-189	175.6				
Rastrelliger kanagurta	143-248	194.2	0.97	Feb-Nov	37690-170455	0.18-0.84
Rastrelliger faughnii	95-239	153.5	1.05			
Trichiurus lepturus	200-979		0.88			
Katsuwonus pelamis	300-650	504.7	1.73	Feb-March	61516-606966	0.23-0.7
Thunnus albacares	330-1980	944.5	0.61	Apr-Aug	398705-11130000	0.18-0.83
Nemipterus japonicus	95-315	177	0.6	Aug-Oct & Feb-March	18407-75874	0.17-0.58
Pennahia macrophthalmus	100-260	188	0.9			
Upeneus vittatus	83-198	138	0.8			
Saurida undosquamis	121-393	214	3.5			
Fenneropenaeus indicus	136-208	171.3	1.07	Feb-June	437500-550000	0.03-0.11
Penaeus monodon	153-295	217.8	0.84	Feb-July	323007-1072174	0.03-0.13
Metapenaeus monoceros (males)	83-188	138.5	1.8			
Metapenaeus monoceros (females)	108-218	156.1		Feb-Sept		
Metapenaeus dobsoni (males)	58-103	87.4	1.2			
Metapenaeus dobsoni (females)	53-108	81.4		Oct		
Portunus sanguinolentus (males)	73-168	126	2			
Portunus sanguinolentus (females)	68-163	120.4		Jan-March & July-Sept		
Sepia aculeata (males)	87-182	119.5	1.1			
Sepia aculeata (females)	94-279	141.8				
Sepia pharaonis	70-300	169	1.5			
Loligo duvaucelii (males)	50-140	76	0.82			
Loligo duvaucelii (females)	60-154	82.3		Round the year	11802-73464	1-1.45

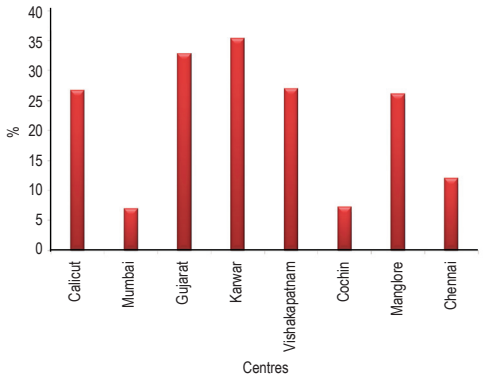
Stock assessment of major finfish and shellfish resources of Andhra pradesh

Species	Stock (t)	Biomass (t)	Biomass per recruit (g)	MSY(t)	Annual average yield (t)	Yield per recruit (g)
Sardinella longiceps (gillnet and seines)	23403	6688	1.04	11303	9096	1.42
Rastrelliger kanagurta (trawl net)	17760	7977	22.43	7538	6302	17.72
Rastrelliger kanagurta (gillnet)	24828	11152	22.43	10539	8810	17.72
Katsuwonus pelamis (hooks and line)	11800	6709	506.9	4227	3824	288.94
Thunnus albacares (hooks and line)	50284	39936	16063.16	9585	11182	4497.68
Trichiurus lepturus (trawl net)	34016	24036	100.40	8893	10095	42.17
Nemipterus japonicus (trawl net)	6171.9	2791.8	20.39	2610.3	3071.0	22.43
Pennahia macrophthalmus (trawl net)	1288.0	334.6	15.75	629.0	890.0	41.891
Upeneus vittatus (trawl net)	6472.2	2607.3	6.17	2881.1	3389.5	8.02
Saurida undosquamis (trawl net)	2057.1	752.96	13.95	944.97	1347.8	24.96
Metapenaeus monoceros males (trawl net-small trawlers)	191.8	176.5	0.6	1218.7	315	3.89
Metapenaeus monoceros females (trawl net-small trawlers)	525.7	505.3	1.97	1776.1	524.1	6.71
Metapenaeus dobsoni males (trawl net-small trawlers)	107.3	107.3	0.2	408.8	172.7	1.01
Metapenaeus dobsoni females (trawl net- small trawlers)	169.2	113.5	0.12	429.6	225.9	1.15
Portunus sanguinolentus males (trawl net-small sona)	95.5	91.9	3.64	300.1	263.8	32.4
Portunus sanguinolentus females (trawl net-small sona)	184.7	152.5	2.24	596.3	433.7	23.5
Sepia aculeata (trawl net)	0.85	0.9	0.22	0.206	0.779	0.121
Sepia pharaonis (trawl net)	2.0	0.7	0.18	0.138	0.782	0.210
Loligo duvaucelli (trawl net)	7.7	4.5	0.03	0.448	1.074	0.006

Fisheries Impact Assessment

Landings of low value bycatch (LVB)

The landings of low value bycatch (LVB) and discards from trawl fisheries was monitored at Veraval, Mumbai, Karwar, Mangalore, Calicut, Cochin, Tuticorin, Mandapam, Chennai and Visakhapatnam. An estimated 1.21 lakh t of bycatch, valued at ₹ 97.2 crores was landed which formed 26% of the total trawl catch. LVB landings showed an increasing trend throughout the coast. At Mangalore, an estimated 301 t of low value bycatch was landed by single day trawlers (SDF) during the period, which formed about 31% of the total catch. The catch rate was highest in February (50%) and lowest in May (34%). At Mangalore Fisheries harbor, 30,435 t of fishes were landed as LVB by multiday trawlers. Maximum landings of LVB were during May. The estimated value of LVB in multiday trawlers (MDF) was about ₹ 30.4 crores and from SDF it was ₹1.5 crores. At Chennai 4,100 t of LVB was landed which formed 12% of the total catch.



Percentage contribution of LVB to the total catch in different centres along the coast of India

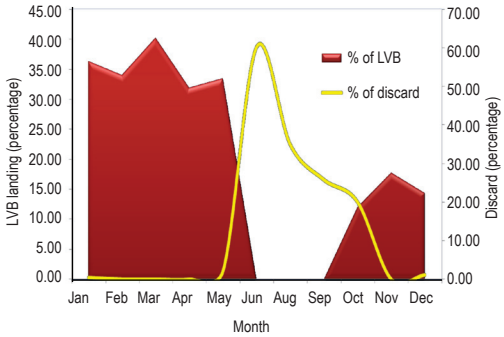
An estimated 12,575 t of LVB valued at ₹ 3.4 crores was landed by trawlers at Calicut. The landings showed an increase of 7.4% when compared to the previous year. Catch rate was highest in April and November and lowest in February. In Versova, Mumbai, an estimated LVB landings of 4,567t were recorded, which formed about 29% of the total catch. Maximum catch was landed in January (44%) and minimum in October (21%). At Visakhapatnam, an estimated catch of 18,911 t of LVB valued at ₹ 4.4 crores was landed which formed 27% of the total landings. The LVB showed an increasing trend. At Veraval, the LVB contributed about 13% (19,450 t) of the total trawl landings. Maximum LVB was estimated in April (41%) and minimum during February and September (22%). At Karwar, single day trawlers contributed 35% (1967 t) LVB to the total landings. Maximum LVB was landed in January and minimum in November. There was an increase of 6% in the LVB at Karwar when compared to the previous year. At Shakthikulangara-Needakara landing centre in Kerala, 1,966 t of LVB was landed which formed 11% of the total catch in that area. At Munambam in Kerala, an estimated total of 1,992 t of LVB was landed which formed 7% of the total landings.

Composition of LVB landing in Calicut

Species composition in LVB

About 52 species were recorded in LVB from Mangalore in MDF, of which 93% were fishes followed by crustaceans (5%) and molluscs (2%). Analysis of LVB landings at Mangalore revealed that *Lagocephalus* sp. (12.8%) dominated the catch followed by *Saurida* spp. (11.7%) *Sardinella longiceps* and *Nemipterus* spp. (8.6% each). In SDF, squilla dominated the catch. At Shakthikulangara - Neendakara in Kerala , about 37 species of fishes were observed in the LVB followed by 18 species of crustaceans and 28 species of molluscs. At Munambam in Kochi, about 25 species of finfishes, 15 species

Species composition of discarded catch from Mangalore



Relationship between LVB landings and discards at Mangalore Fisheries Harbour in 2011.

Juveniles of *Epinephelus* landed by trawlers in Mangalore

of molluscs and 16 species of crustaceans were observed. At Mumbai, 51 species of finfishes, 20 species of crustaceans and 11 species of molluscs were observed in LVB. At Veraval, 41 species of finfishes, 13 species of crustaceans and 3 species of molluscs were recorded. At Karwar, 56 species of finfishes and 11 species of crustaceans were observed in LVB. At Chennai, fishes formed about 63% of the LVB, crustaceans formed 31%, molluscs formed 5% and sponges, ascidians and echinoderms formed 2%.

Discarded bycatch

There was an overall reduction in discards from trawlers especially along the southwest coast of India, which came down to less than 10%. At Mangalore, an estimated catch of 7,359 t were discarded by MDF during 2011, which shows that total catch include an addition of 6.3% than those landed. Maximum discard in MDF was observed during June. Multiday trawlers discarded the LVB in the early part of the cruise. At Calicut, 1,957 t was estimated to be discarded which formed about 4.2% of the total catch. It was observed that the quantity of trawl discards has come down and now it forms only negligible portion of the catch. The discard was highest during March-May, 2011. At Calicut, about 178 species of fishes and shellfishes were observed in the discards. In this, about 124 species were finfishes (88%) followed by crustaceans and molluscs. At Mangalore, 204 species/groups were identified from discard samples. About 116 finfishes, 31 gastropods, 4 bivalves, 7 cephalopods, 13 shrimps, 3 stomatopods, 21 crabs, 3 lobsters and juveniles of unidentified sharks and rays were recorded from the discarded bycatch. Apart from this, species representing the groups like sponges, star fishes, sea urchins, jelly fishes and sea snakes were also observed. Among fishes, *Saurida* juveniles and *Lagocephalus inermis* were found during majority of days.

Juvenile fishery

At Mangalore, 98% of *Epinephelus diacanthus* were juveniles, followed by *Scomberomorus commerson* (95%), *Saurida* spp. (50%) and *Nemipterus* spp. (41%). Other juvenile fishes were *Priacanthus hamrur* (32%), *Decapterus russelli* (29%), *Megalaspis cordyla* (20%), *Lactarius lactarius* (18%), *Cyanoglossus macrostomus* (10%) and *Trichurus lepturus* (8%). At Calicut, highest juvenile contribution by weight was recorded in *Nemipterus randalli* (3,277 t) and *N. japonicus* (1,587 t). The juvenile composition of other dominant species were *Leiognathus bindus* (48.2%), *Johnieops sina* (38.2%), *Otolithes ruber* (34.1%), *Secutor insidiator* (25.8%), *C. macrostomus* (28.4%), *Saurida tumbil* (28.2%) and *Sphyraena obtusata* (18.4%). The economic loss due to the discarding of low value and juvenile fishes by trawlers at Calicut is estimated at ₹ 3.4 crores. In Veraval the highest percentage of crustacean juveniles (female) was noticed for *Charybdis feriata* (100%), *Portunus pelagicus* (100%), *Portunus sanguinolentus* (100%), *Metapenaeus monoceros* (100%), *Metapenaeus kutchensis* (100%), *Metapenaeopsis stridulans* (100%), followed by *Parapenaeopsis stylifera* (8.5%), *Exhippolysma taensirostris* (97.2%), *Solenocera crassicornis* (94%), *Scylla serrata* (93.5%), *Oratosquilla nepa* (61.7%) and *Acetes indicus* (19.5%). An assessment of the composition of LVB at Chennai over the last five years show an increase in the percentage of juveniles.

Selective fishing

Dolnet fishery: In Maharashtra, dolnet fishery observation was done in Arnal, Sassoon Docks and Versova. Duration of each haul of dolnet was 3 h. Total catch in dolnet in Arnala was estimated at 4819 t for the effort of 53154 (hauls) and catch rate was 90 kg h^{-1}. Major groups contributing to dolnet fishery at Arnala were Bombayduck (32%), non-penaeid prawns

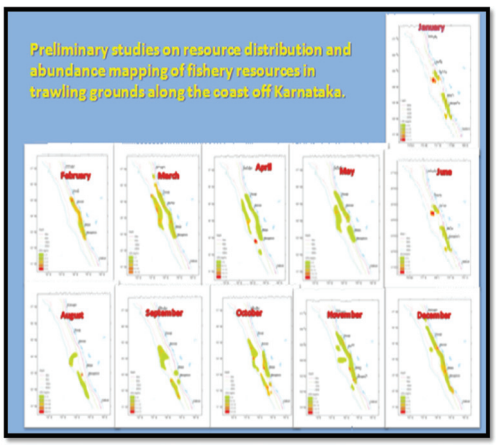
(31.5%). anchovies (1.5%) and more than 50% of the catch comprised of juveniles. At Sassoon Docks, the total catch was estimated at 123 t for an effort of 18232 and the catch rate was 9 kg h^{-1}. Major groups contributing to the fishery were anchovies (27%), non-penaeid prawns (17%), croakers (15%), sardines (7.5%) Bombayduck (7%) and Ribbonfishes (6%). At Versova, total catch was estimated at 36 t for the effort of 221 units and catch rate was 41 kg h^{-1}. Major groups contributing to the dolnet fishery at Versova were Bombayduck (50%), non-penaeid prawns (15%), anchovies (12%) and ribbonfishes (6%).

***Thallumadi* fishery:** Estimation of annual catch of *thallumadi* fishery at Tuticorin, Tamil Nadu showed that 104.7 t was landed with a CPUE of 15 kg. Out of this, prawns formed 41% (43 t), crabs 46% (48.5 t), fishes 7% (7 t) and cephalopods 6% (6 t). The monthly effort varied from 217 to 1008 and the annual effort was 6,838 units. The dominant species in *thallumadi* catch was *Penaeus semisulcatus* (37%), *Portunus pelagicus* (20%), *P. sanguinolentus* (14%) and *Charybdis natator* (12%).

Nemipterus juveniles landed by trawlers in Mangalore

Spatio- temporal analysis of time series data on resource distribution in Karnataka

Spatio-temporal distribution of resources along the Karnataka coast was mapped using ArcGIS. Visual Basic was used which was populated with data of commercial catch and discards, which comprises geographic coordinates, water depths, net types, commercial fish, discard species *etc.* Thematic shape files/feature classes were prepared by sending queries into these tables. The total number of species caught monthly varied from 106 to 154. Maximum number was caught in May and minimum in February. Major resources caught were *Nempiterus* spp. and other major contributors were cuttlefish, *Lagaocephalus* sp., *Trichiurus lepturus, Saurida* spp., *Priacanthus hamrur* and *squilla.* Maximum catch of *Nempiterus* spp. was in August. Cuttlefish formed the major catch during the post-monsoon period. Present study even though not comprehensive, provides a fairly good picture of the resource distribution and abundance of fishery resources in commercial fishing grounds. The study is based on the data from single sampling boat and by incorporating more trawlers in the experiment in future, a comprehensive picture of resource distribution off Karnataka coast can be obtained.

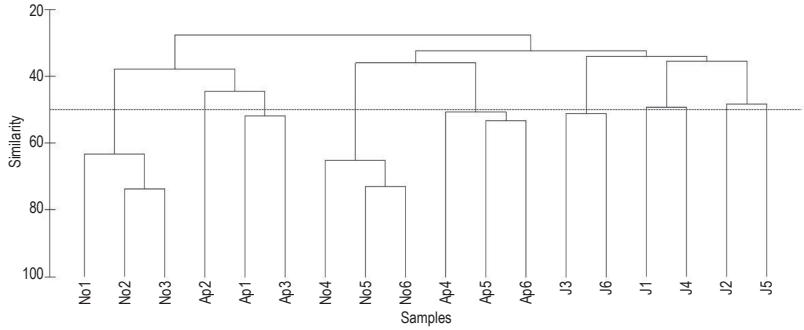


Sptio-temporal distribution and abundance of fishery resources off Karnataka coast.

Experimental trawling

Experimental trawling was done along the Karnataka coast to assess the impact of trawling. Three experimental trawlings were conducted during January, April and November upto 30 m depth. Total number of species recorded was 16 in January, 23 in April and 21 in November. In January, 27% of the catch comprised of *C. hoplites* followed by squilla which constituted 26% of the catch. Other major species were *C. smithi* (12%), *Cyanoglossus macrostomus* (9%) *Nemipterus* spp. (7%) and *Thryssa* sp. (6%). In April, 14% of the catch was contributed by *C. macrostomus,* followed by *P. stylifera* (12%) *Lagocephalus* (10%) and *Saurida* spp. (7%). In November, *Johnius* sp. (12.7%) dominated the catch followed by *C. macrostomus* (11%), *Squilla* (10%), *P. stylifera* and *C. hoplites* (9%).

Species diversity indices (H' Log2) ranged from 3.67 to 4.17, highest in April and lowest in January. The evenness was in the range of 0.97-0.98. The cluster analysis showed a similarity between April and November to which January got linked. There is clearly a low level of similarity between samples J1 to J6, and the remainder of the samples (<50% similarity). Majority of the other samples have more than 60% of similarity. All environmental parameters were assessed in different months. There was no significant difference between the environmental parameters between months.



Cluster analysis showing similarity of species in different months

Percentage of juveniles in multiday trawl landings at Mangalore

Species / Group	Catch (t)	Juvenile (%)
Epinephelus diacanthus	2109	98
Scomberomorus commerson	792	95
Saurida spp.	3437	50
Nemipterus randalli	10283	41
Priacanthus hamrur	328	32
Decapterus russelli	3018	29
Megalaspis cordyla	597	20
Lactarius lactarius	160	18
Cynoglossus macrostomus	167	10
Trichurus lepturus	683	8

Percentage of juveniles in multiday trawl landings at Calicut

Species / Group	Catch (t)	Juvenile (%)
Epinephelus diacanthus	194	98.1
Leiognathus bindus	63	48.2
Otolithus ruber	10	38.5
Nemipterus randalli	3277	34.5
Johnieops sina	46	33.8
Nemipterus japonicus	1587	29.5
Secutor insidiator	8	28.8
Cynoglossus macrostomus	512	28.4
Saurida spp.	554	28.2
Sphyraena obtusata	6	18.4

Oceanic Resources

Yellowfin tuna (*Thunnus albacares*)

Yellowfin tunas were harvested by the commercial fishers mainly by lines (longlines and pole & line) from oceanic waters at depths beyond 300m. A small proportion of yellow fin tunas exploited were also landed by large meshed gillnets operating in deeper waters. An estimated 1,36,387 t was landed annually along Indian coast during 2006-2010. This formed 43% of the total tuna production of the country. The catch was supported by 22-201cm fishes with 73.9 cm as annual mean size. Smaller fishes of 45-100 cm size dominated catch. Length at capture in gillnets was 50.2 cm and in hooks and line it was estimated as 78.7 cm. The smallest maturity size was 54.5 and 57.6cm respectively for male and female. The relative fecundity varied between 1,97,263 and 8,14,557/kg body weight with a mean of 4,36,330. Spawning period extended from June-January with peak activity during July-October. Optimum length for exploitation was estimated at 61.1 cm. Recruitment was observed during several months with peak in May-August. This period accounted for 60.5% of the annual recruitment.

Yellowfin tuna fed mainly on fishes (carangids, clupeids, belonids, hemiramphids, ribbonfishes, tunas, perches, mesopelagic fishes), pelagic crabs (*Charybdis* sp.), shrimps (*Solenocera* sp.) and cephalopods (*Synplectotheuthis* sp.). Growth parameters estimated were; L_{∞} = 211.1 cm (FL), K=- 0.27/year and t_o = -0.056 years. Study revealed presence of large proportion of spawning stock biomass to the order of 85.8% of the standing stock and there exists considerable scope for expanding their fishery in the Indian waters.

Yellowfin tuna

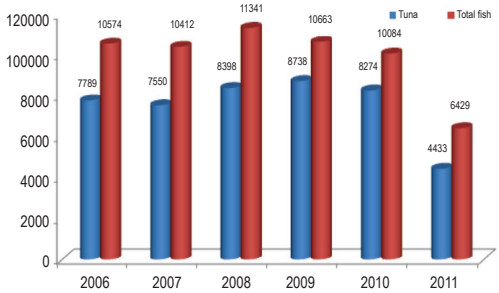
Satellite (psat's) tagging of yellow fin tuna in Indian waters

The migration and movement of large fishes especially those which are known to swim long distances have been tracked using several direct and indirect methods. Information gathered so far by conventional archival tagging methods has been limited and very little is still known on the migration behavior of the these fishes, the reasons for undertaking such long migrations if any, the dives they take during a day, and in the case of schooling fishes if the fish in a region belong to the same single stock or is shared. Further, conventional archival tags used have a number of disadvantages with very poor recovery rates and limited data on habitat and environment. The "Pop-up Satellite Archival Tags" (PSAT) have been developed to avoid such problems, track fish and reveal ocean-wide movements.

Pop-up X-tag supplied by Microwave Telemetry Inc. was deployed on yellowfin tuna (*Thunnus albacares*) for the very first time in Indian waters by the Central Marine Fisheries Research Institute during December 2011 to February 2012. A total of 15 tags were deployed in two phases along the Bay of Bengal and the Arabian Sea with the pop-up time ranging from 4 months

to a year. Tagging was done in the Bay of Bengal Region from Visakhapatnam where eight tags were deployed and along the Arabian Sea, seven tags were deployed off Lakshadweep Islands.

The tagging programme is funded by INCOIS under the project entitled "Satellite Telemetry studies on Migration patterns of Tunas in Indian Seas" (SATTUNA). With this achievement India joined the elite group of countries engaged in satellite tracking of yellowfin tuna.



Total fish and tuna production trend of Lakshadweep during 2006-'10

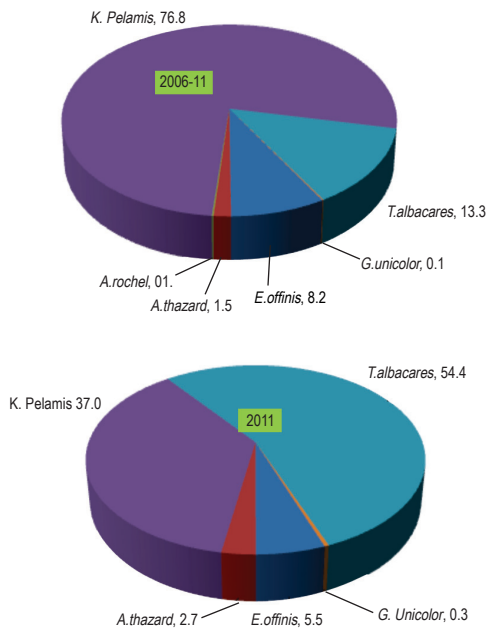
Oceanic tuna fisheries in the Lakshadweep Sea

Tuna landing of Lakshadweep during 2006-2011 reached peak in 2009 and thereafter registered doward trend registering the lowest catch of 4,438t in 2011. The declining trend was mainly due to the decreased contribution of skipjack tunas. Production of total tuna declined by 46.3% and skipjack by 83.9 % in 2011 compared to 2010. Considerable decline in the abundance of skipjack was also reported along the traditional fishing grounds.

Yellowfin tuna production maintained its increasing trend throughout the period. Landings increased steadily from 986 t (2006) to 2,416 t in 2011 due to targeted fishing. Traditionally tunas are exploited along the coast of Lakshadweep using pole and lines, gillnets and handlines and the catch is constituted by young small skipjacks, yellowfins, other tunas and pelagic fishes. With the increased awareness on the commercial value of hitherto less targeted large yellowfin tunas, fishers diverted some attention to exploit them using double pole and lines, handlines and troll-lines from the traditional pablo boats.

Potential fishing ground for yellowfin tuna was identified between latitude 8 - 12° N and longitude 73-74.4° E and mapped based on experimental tuna longlining. Study indicated that for the sustainable exploitation of yellowfin stock handlining/trolllining/multiple pole & lining/longlining should be encouraged.

Fishing activity is restricted within the nearshore waters in the close vicinity of the Islands and the present production is only around 15% of the estimated potential (50,000 t) of the region. The fishery scenario indicated considerable scope for enhancing production from the oceanic waters.



Change in species contribution to the total tuna catch of Lakshadweep during 2010 & 2011

Tuna fishing fleet

Vessel category and gear types	Fleet strength (Nos.)
Pablo boats (Pole & line/hand line/ troll line/gillnet units)	295
Traditional units - motorised and non-motorised (gillnets/handlines	370

Tuna landings in Lakshadweep (t) during 2006-'11

Species	2006	2007	2008	2009	2010	2011	Average
E. affinis	311	227	2343	259	192	246	596
A. thazard	125	121	88	141	133	120	121
A. rochei	23	23	1	1	1	0	8
K. pelamis	6603	6236	5112	7059	6294	1641	5491
T. albacares	709	929	854	1272	1650	2416	1305
G. unicolor	16	15	0	6	4	15	9
Total	**7786**	**7550**	**8398**	**8738**	**8274**	**4438**	**7530**

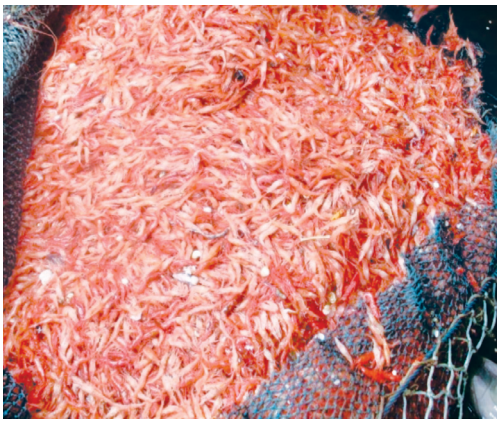
Issues and recommendations

The potential of yellowfin tuna in Lakshadweep waters is not fully exploited. Fishing activity should be intensified and expanded/extended beyond the traditional fishing grounds to trap the potential.

The main hindrance is lack of large vessels with adequate carrying capacity for oceanic fishing, storage, processing and marketing facilities. Island based vessels with combination of different gears and adequate facilities for oceanic tuna fishing have to be introduced with Institutional support. Carrier vessels with onboard processing and storage facilities may be deployed to collect the catch afresh and to process or transport to the processing centres. Adequate infrastructure may be developed at strategic islands to handle the catch.

Though monofilament longlining from modified Pablo boats for yellowfin tunas were introduced, it did not yield desired results, probably due to lack of operational skills. Skill enhancement in long lining/oceanic fishing should be taken up on a priority basis.

Island based infrastructure facilities for handling increased catch is lacking. As yellowfin tunas are available very close to the coast, this will be the most ideal location for developing Sashimi grade products. Special Economic Zones may be developed to promote fishery based export oriented industries.



Bulk catch of deep- sea shrimp *Metapenaeopsis andamanensis*

Oceanic resources of the continental slope and Central Indian Ocean

An exploratory deep-water fisheries resource survey onboard Fishery Oceanography Research Vessel *Sagar Sampada* (Cruise 291) was undertaken during 22-10-11 to 10-11-11 covering latitudes 13^0 and 20^0 N on the east coast of India. Seventy four species of deep sea fishes were recorded.

A fishing ground for deep sea aristeid shrimp *Plesiopenaeus edwardsianus* was located off Trivandrum on the west coast of India at about 900 m depth. Major catch of shrimps, *Metapenaeopsis andamanensis* was obtained at 14^0 N on the west coast.

A new record of *Harpadon* species was identified from the deep-sea off northwest coast of India. Genetic barcodes generated from *Harpadon* species collected from landings of nearshore operated commercial fishing vessels and offshore waters from exploratory surveys indicated that there are two distinct groupings from the two habitats.

Oceanic squids

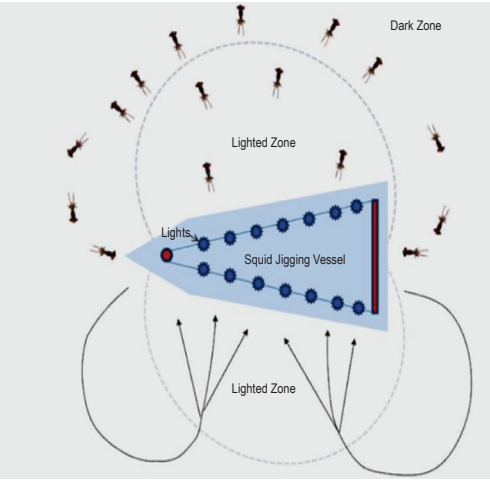
Efficiency of oceanic squid fishing methods were compared. Gillnet catch rates were relatively higher, followed by mechanised jigging in larger vessel. Dorsal mantle lengths (DML) of oceanic squids caught in different gears were also compared. Fishable biomass of big fin reef squid *(Sepioteuthis lessoniana)* was detected in Agatti Island waters and method of capture by lift nets from Pablo Boats was developed. Stomach analysis of *Sthenoteuthis oualaniensis* using IRI (Index of Relative Importance) methods found that finfish formed 55%, squid formed 40% and crustaceans 5%.

Oceanic squids caught in gillnet

Product development

The following value added products were developed

- Oceanic squid IQF products in three different packing styles (whole tubes, strips and rings)
- Oceanic squid curry – ready to eat in one packing style



Schematic representation of oceanic squid movements around squid jigging vessel during operations

- Squid meat with squid ink in two different packing styles
- Fiery hot dried squid as cocktail snack

Three types of collagen (acid soluble, pepsin soluble and Indigestible collagen) were extracted from squid skin. Amino acid analysis, Fourier Transform Infrared Spectroscopy (FTIR) and Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) were carried out. Proximate analysis of the dried oceanic squid was done. Squid Protein Concentrate prepared and its nutrient quality analysed. Squid silage was prepared and evaluation of its nutrient quality is being carried out. Squid Peptide extract has been prepared and the bioactivities (anti-oxidant, anti-microbial and anti-inflammatory activities) are being tested.

Training programme on Value added product development from Oceanic squid was conducted from 29.06.11 to 01.07.11 for 14 fisherwomen from SHGs.

Trial marketing of products developed from NIFPHATT Fish Stall, Kochi under the brand name – ARABIAN SEA MASTER SQUID was undertaken

Myctophids

The annual catch of myctophids during 2010-'11 was 2,972 t. Fishery occurred almost round the year with peak during November-February. Catch was supported by five species *viz.*, *Diaphus watasei, Diaphus garmani, Benthosema fibulatum, Myctophum obtusirostre* and *Neoscopilus microchir. D. watasei* and *N. microchir* together constituted 94 % catch and were available round the year. Taxonomic samples were collected from off Veraval coast and Lakshadweep waters.

Diaphus watasei

Bentonsema pterotum

Symbolophorus rufinus

Myctophum spinosum

Diaphus thiollieri

Myctophids of Lakshadweep waters

Population reference points of *D. watasei* exploited by deepsea trawlers

L_r FL (cm)	L_{max} FL (cm)	L_{mean} FL (cm)	T_r (yr)	Tmax (yr)	L_{c50} FL (cm)	L_{opt} FL (cm)	L_∞ FL (cm)	K (yr^{-1})
4.3	14.3	95.6	0.4	3.7	7.9	9.1	15.1	0.8

L_{mat} FL (cm)	T_{mat} (yr)	Relative fecundity (per g body wt.)	Spawning season	M	F	Z	E
10.1	1.4	850	January-August	1.21	0.47	1.68	0.279

Population parameters of *D. watasei* were estimated and stock assessment was carried out. The results indicate that the stock is at its initial stage of exploitation and have large scope for enhancing their commercial exploitation. However, their distribution, stock abundance and potential, need to be assessed.

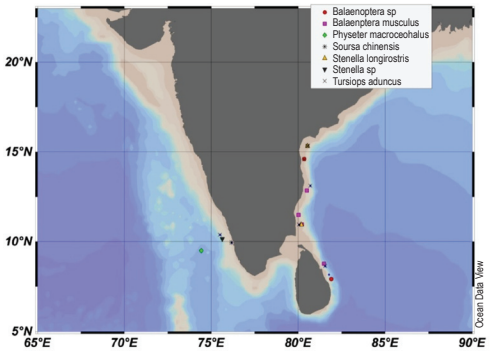
Bio-chemical analysis of *D. watasei* showed that they are nutritionally comparable with other common food fishes and can be considered as an alternate source of protein and fat for future.

DNA barcodes (cytochrome c oxidase subunit I (COI) gene) were generated for *D. watasei, D. garmani N. microchir* and *B. fibulatum*. The sequences were submitted to BOLD (Accession number: BDF001-12, BDF002-12, BDF003-12, BDF004-12, BDF005-12, BDF006-12, BDF007-12, BDF008-12). Ecopath database for 18 co-existing species were developed.

Marine Mammals

Between April and December 2011, two oceanic opportunistic visual surveys were carried out onboard FORV *Sagar Sampada* to assess marine mammal diversity and their distribution in oceanic waters of Indian Seas and Indian Ocean. During cruise No. 288, the survey was conducted between 10°N and 13°N alone west coast for 8 days. A total of 64 h was spent to survey 188.4 nautical miles (nm). The encounter rate was 1.32 per 50 nm and 0.07 per hour. Three species of Delphinidae family namely, *Stenella* sp., *Sousa chinensis* and *Tursiops aduncus* were observed and *Physeter macrocephalus* (sperm whale) was the only larger whale observed in this cruise

During onset of northeast monsoon another survey (Cruise 290) was carried out between 10°N and 15°N alone east coast of the Indian seas and southern part of Sri Lankan waters (Indian Ocean). The survey duration and area surveyed were 162 h and 1225 nm, respectively. A total of 25 sightings of three species were recorded in these cruises. The encounter rate was 2.04 per 100 nm and 0.1 per hour. Species diversity observed in this cruise was low. *Stenella longirostris* and *Tursiops aduncus* were the delphinids sighted frequently during this cruise. *Balaenoptera musculus* (blue whale) were recorded on a few occasions in Indian (off Chennai) and Sri Lankan waters. *Balaenoptera edeni* (Bryde's whale) was sighted off Kakinada. High frequencies of occurrence of baleen whale *(Balaenoptera* sp.*)* were observed along the eastern Sri Lankan waters.

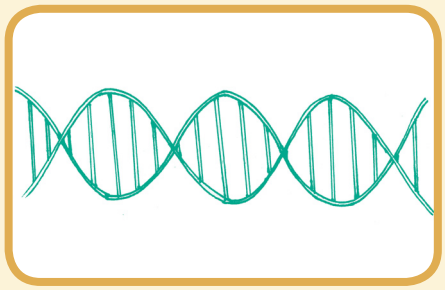


Map showing locations of cetacean sightings during cruise nos. 288 and 290

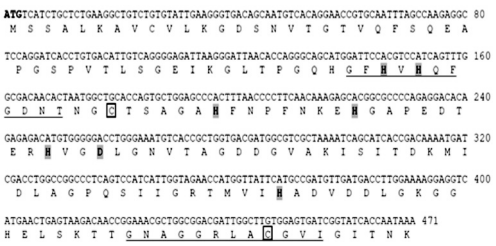
Bryde's whale *Balaenoptera edeni*

Indo-Pacific bottlenose dolphin *Tursiops aduncus*

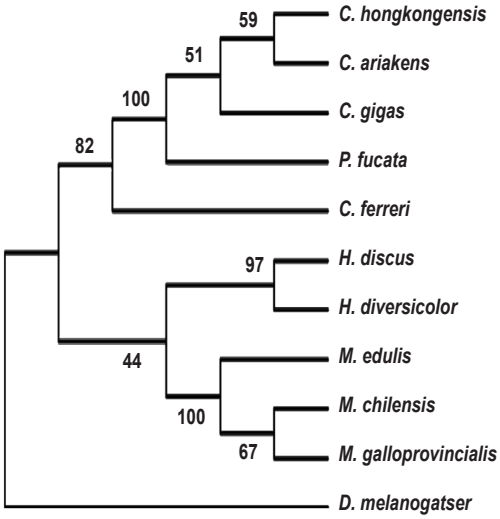
Cruise No.	Area	Period & Duration	Effort	No. of sightings & individuals	Species recorded
288	Southwest coast (Kochi-Mangalore-Kochi)	4th to 11th August 2011 (8 days)	64 h & 188.5 nm	5 & 34	*Sousa chinensis* *Physeter macrocephalus* *Tursiops aduncus* *Stenella* sp.
290	Southeast coast (Chennai-Vizag-Chennai)	1st to 15th October 2011 (14 days).	162 h & 1225 nm	25 & 204	*Stenella longirostris*, *Tursiops aduncus*, *Balaenoptera* sp.



Fish Genetics and Genomics



Nucleotide sequence of pfSOD cDNA from *P. fucata* and its deduced amino acid sequence. Two Cu/Zn SOD family signatures are underlined (_). The amino acids required for copper (His-49 -51, -66, and -123) and zinc (His-66, -74, and -83 and Asp-86) binding are shaded. Two cysteines (Cys60 and Cys149) predicted to be engaged in the disulfide bond formation are boxed



Phylogenetic tree based on the selected Cu, Zn SODs

Biotechnological applications in mariculture and conservation

Characterisation of functional genes for disease resistance in *Pictada fucata*

Characterisation of the genes *viz*., superoxide dismutase (Cu/Zn SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione-S-transferase (GST) of *P. fucata* was carried out during the period. RNA was isolated from the haemocytes, cDNA synthesised and amplified using gene specific primers designed based on the sequence information from the Genbank data base. Purified PCR products were sequenced and analysed.

Cu, Zn Superoxide dismutase gene

PCR amplified fragment of cytoplasmic copper/zinc SOD (471 bp size) was sequenced and checked for identity and similarity to known sequences by BLAST and multiple sequence alignment was generated using CLUSTAL W program. The nucleotide sequence showed higher identities with other known SODs from molluscs. Signal peptide prediction was performed by Signal P. Protein family signatures were identified using Inter Pro program.

Open reading frame (ORF) of 471 bp encoding a polypeptide of 157 amino acids was obtained. No signal peptide was identified in the deduced amino acid sequence of Cu Zn SOD by the signal P program, indicating that pfSOD was a cytoplasmic Cu, Zn SOD. Two Cu, Zn SOD family signature sequences, signature1 (consensus sequences : [GA]-[IMFAT]-H-[LIVF]-H-{S}-x-[GP]-[SDG]-x-[STAGDE]) and signature 2 (consensus sequences : G-[GNHD]-[SGA]-[GR]-x-R-x-[SGAWRV]-C-x(2)-[IV]) were found in the pfSOD deduced amino acid sequence.

Phylogenetic analysis

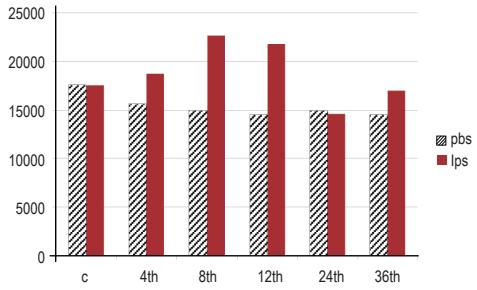
Phylogenetic tree based on the amino acid sequences of the selected Cu Zn SODs using the neighbour-joining method was constructed with a bootstrap value of 1000.

Quantitative expression analysis of immune genes

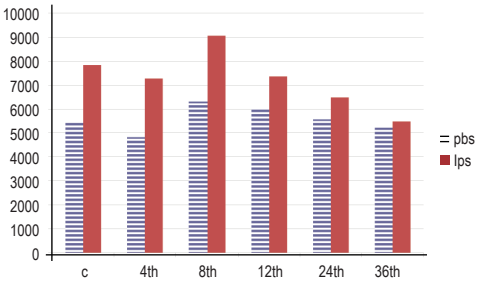
Expression pattern of GPx and GST genes from *P. fucata* was studied. Adult *P. fucata* (about 4.5-5.5 cm in shell length and 20-30 g body weight) were challenged with lipopolysaccharide (LPS; *Escherichia coli* 055:B5), and expression profile of these genes was monitored in time series. Haemolymph from the control and the LPS stimulation group was collected at definite time intervals (0, 4, 8, 12, 24 and 36 h) and total RNA isolated and used for cDNA synthesis. cDNA of the genes under study was amplified and their

expression levels at different intervals were determined by semi-quantitative PCR analysis. Housekeeping gene 18s was used as reference for calculation of relative expression levels of target genes. GAPDH was used as the positive control. The products were analysed on 2% agarose gel.

The expression levels at different time intervals were quantified from the gel band intensity using Image J analysis software. The expression levels of SOD, GPx and GST in the challenged animals were up regulated between 4th to 12th hours with slight variations among the different time periods. The results indicated the possibility of using these genes as biomarkers for marker assisted selective breeding of pearl oysters for enhanced resistance.



Expression levels of GPx gene in *P. fucata* challenged with LPS

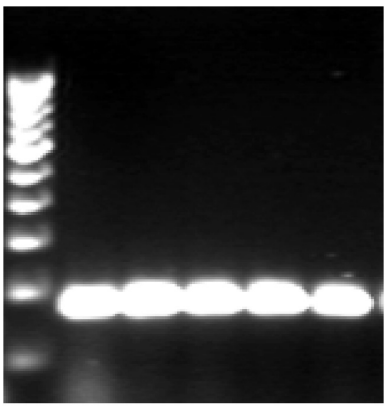


Expression levels of GST gene in *P. fucata* challenged with LPS

Characterisation of functional genes in *C. madrasensis*

Identification and molecular characterisation of Glutathione peroxidase (GPX)

Characterisation of the gene encoding an important antioxidant enzyme, glutathione peroxidase (GPX) which removes the toxic hydroperoxides by breaking them into water and oxygen, and thereby playing a role in the defense mechanisms was carried out. As there were no reports about the molecular structure of GPX in *C. madrasensis*, DNA sequences, information of pacific oyster available in the database were used to design and custom synthesise the primers for PCR amplification of this gene in *C. madrasensis*. The RNA from the gill was isolated and reverse transcribed through RT PCR to synthesise cDNA. PCR trials were carried out with this cDNA as a template with different combinations of primers synthesised. An amplicon of about 147 bp as expected was obtained in a high stringency PCR. The amplified PCR products were gel eluted, purified and sequenced. The sequence obtained on similarity search showed homology to the sequence of *Crassostrea gigas* GPX available in the NCBI Blast database.


PCR amplified GPX gene segment from *C. madrasensis*

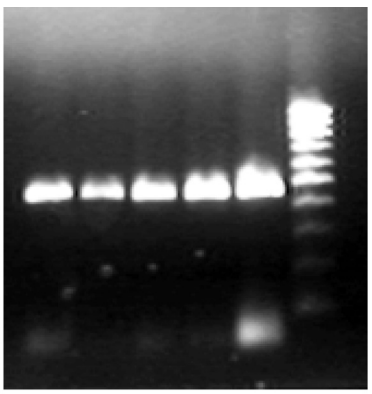
Superoxide dismutase (SOD) gene of *C. madrasensis*

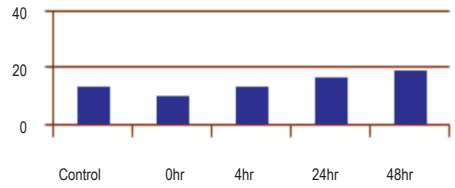
Characterisation of the anti-oxidant enzyme gene, superoxide dismutase was carried out. The DNA sequence was analysed with the protein domain identifier software Inter Pro Scan. The analysis revealed the characteristic domains classifying the gene as Cu/Zn SOD. PCR trials to amplify the gene from both genomic DNA and cDNA revealed some peculiar features of this gene. PCR reactions using both genomic DNA as well as cDNA as template resulted in the amplicon of same size *viz.*, 464 bp. This has clearly indicated the absence of introns in this gene. This is in contrast with SOD gene of other species where introns are present. It has been suggested that the lack of introns may help to circumvent the block of RNA splicing, allowing the rapid synthesis of proteins. This characteristic enables ready expression of these proteins during periods of stress.

Expression analysis of stress tolerance genes under stress

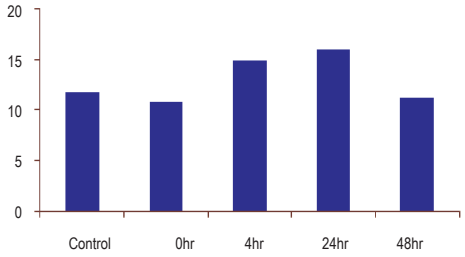
SOD

Having carried out the characterisation of SOD gene, trials were conducted to study the expression of these genes on exposure to thermal stress. Thermal shock was given at sublethal temperature of 40°C for one hour. Gills from control and test oysters were excised at regular intervals. Total RNA was isolated from the gill tissue and cDNA was synthesised to study quantitative gene expression. Transcription analysis through semi-quantitative PCR using cDNA have shown the regular upregulation of the SOD gene expression as time proceeds after the thermal shock.


Amplified SOD gene segments from genomic DNA and cDNA template of *C. madrasensis*



The expression levels of SOD gene in *C. madrasensis* exposed to thermal shock



The expression levels of HSP90 gene in *C. madrasensis* exposed to thermal shock

HSP90

Earlier experiments reported last year, have shown the upregulation of HSP70 following thermal shock which in turn induced thermo-tolerance. Similar trial was carried out during this year with HSP 90 gene which was identified and characterised during the last year in *C. madrasensis*. Thermal shock experiments and subsequent quantitative expression analysis have shown a moderate upregulation of HSP90.

It can be inferred that the increased expression of these stress related genes such as HSP70, HSP90 and SOD are contributing to the induced thermo-tolerance, a phenomenon of acquiring better tolerance to temperature among animals previously exposed to sublethal temperature.

An interesting observation from these studies is the fact that moderate level of expression of the antioxidant enzyme SOD and heat shock protein HSP90 genes are being maintained even in the control animals. This clearly supports the 'Prepared for stress" hypothesis meaning that the bivalves living in intertidal zones with varying environmental regimes are physiologically equipped to overcome the environmental challenges. The expression profile of these stress related genes in bivalves can be used for environmental biomonitoring.

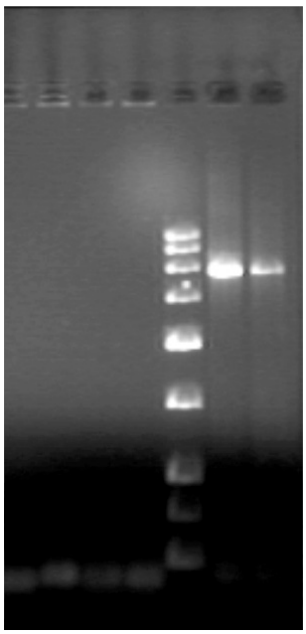
Amplification of full Open Reading Frame (ORF) of Hsp70 gene

The partial amplification and sequencing of Hsp70 gene of oyster using primer pairs designed from the preliminary sequence data were reported last year. Full length ORF of Hsp70 (1.9 Kb) was amplified by PCR using custom synthesised primers. Trials are being undertaken to amplify the full length c-DNA of Hsp70 through 5' prime and 3' prime RACE using these primers.

Fish genetic stocks

Molecular genetic profile of *Pinctada fucata* and *Crassostrea madrasensis* from natural habitats

Molecular characterisation of the pearl oyster *Pinctada fucata* and the edible oyster *Crassostrea madrasensis* from different natural habitats using microsatellite markers to document their intra-species genetic variability and to identify distinct genetic stocks if any for breeding strategy and conservation has been carried out. Molecular characterisation with respect to mitochondrial DNA markers like Cytochrome b, ATPase 6 and Control region have been reported last year.



ORF of Hsp 70 of *C. madrasensis* visualised in agarose gel

Microsatellite markers developed

In order to develop microsatellite primers for *C. madrasensis* and *P. fucata*, cross species amplification of microsatellite loci using the primers from closely related species were tried. Microsatellite primers from *Crassostrea gigas* were tried with *C. madrasensis* and primers from *Pinctada margaritifera* and *Pinctada maxima* were tried with *P. fucata*. Out of the primers screened for cross species amplification in *C. madrasensis*, 6 pairs were selected for further screening and analysis. In *P. fucata*, 5 pairs from *P. margaritifera* and 1 pair from *P. maxima* were selected.

The primers identified for *C. madrasensis* and *P. fucata* are being used for amplification of the microsatellite regions of the samples collected from different natural habitats, to be followed up with automated genotyping for the population structure analysis.

Microsatellite primers selected for population screening of *C. madrasensis*

Sl. No	Locus Name	Primer Sequence 5'- 3'	Product size
1	ucdCg130	CCGACAGTCGTCACCTTTTT TTCCAGCATCACTGCAGATT	114-124
2	ucdCg138	CCTCGAACAGCACTCCAAAT TTCAGTTCAACGCTCTTGCT	220-300
3	ucdCg172	CCACCGTTAAACGTAGCATTG TTGTGTCCCTTTTCCGTCTC	231-246
4	ucdCg182	TCAGACCTGAGAACGTGTGTG TTGGTAGCAAGATCGGGAAA	217-240
5	ucdCg185	CTGAAATGTCACGAACTGCAC AACCGGTTTGTGTATTGATGC	170-206
6	ucdCg199	GGGAAGAGTTGAATTCTGCAA AAACCGAGGCTCAGGAAAAT	250-271

Microsatellite primers selected for population screening of *P. fucata*

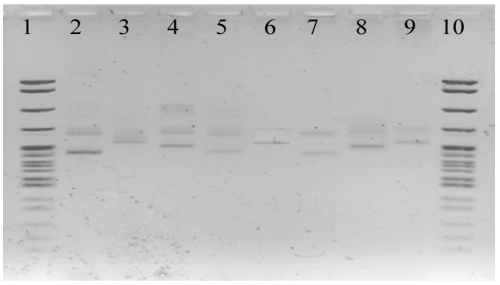
Sl. No	Locus Name	Primer Sequence 5'- 3'	Product size
1	Pmarg2	GATCCTACGATGATTGCTTTGTC TGCAACGTATCAGGTTATGTTTG	215-230
2	Pmarg7	CGTCAGTGGGAGTCAAATATTCG AGGAAGGGCATGTCATAAGGAAC	290-320
3	Pmarg11	TCTGTCCGTCCATCTAGC ACAATGCATATCAAGTCAGC	120–230
4	Pmarg44	GGACAGGGAATATCAAAC CAAATATGTGCAGTGTGAC	110
5	Pmarg77	GTTCAGCCATTCTTGAGAAG TGAGCAATATTTAGCTCGAAG	292-304
6	JCUPm27_d7	TACTGGCATGGAATACTGTAG ATCGTGTTACAACCAAAGTG	123–151

Standardisation of the Nested PCR for diagnosis of *Perkinsus* spp.

The two step (Nested) PCR developed as a more specific and sensitive alternative to the OIE suggested conventional diagnostic techniques was tested extensively for its specificity and sensitivity. The PCR showed high sensitivity and specificity when compared to the Rays Fuid Thioglycollate Medium (RFTM) assay and conventional 1st step PCR in a variety of samples examined from various bivalve populations. The technique was standardised and the results clearly show that it can detect *Perkinsus* infections which could not be diagnosed using RFTM and first step PCR. This nested PCR could be suggested as a confirmatory test for *Perkinsus* spp. along with RFTM. This nested PCR is being used for the epidemiology studies of P. *olseni* among the cultured bivalves.

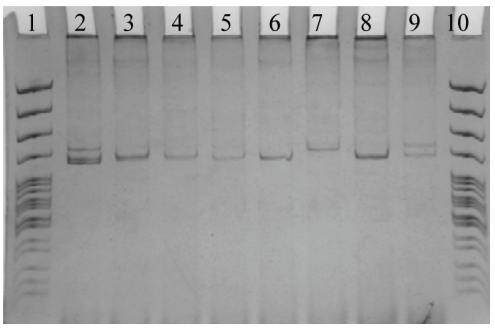
Ornamental transgenics

For development of a fluorescent transgenic fish expressing fluorescent proteins in their muscles, Beta-actin Promoter region amplified from *Etroplus maculatus* and *Danio rerio,* were cloned, sequenced and characterised. These promoters were used for constructing four different transgene constructs for production of transgenic green and red fluorescent fish.



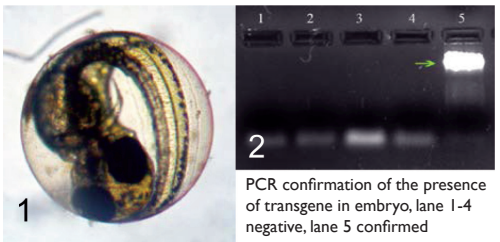
Lane 01: pBR322DNA/Msp I Digest
Lane 02: CmTUT10
Lane 03: CmTUT11
Lane 04: CmTUT12
Lane 05: CmTUT13
Lane 06: CmTUT14
Lane 07: CmTUT15
Lane 08: CmTUT16
Lane 09: CmTUT17
Lane 10: pBR322DNA/Msp I Digest

Profile of microsatellite loci ucdCg138 amplified in *C. madrasensis* samples using primer ucdCg138F&R from *C. gigas*



Lane 01: pBR322DNA/Msp I Digest
Lane 02:TPF01
Lane 03:TPF02
Lane 04:TPF04
Lane 05:TPF05
Lane 06:TPF14
Lane 07:TPF16
Lane 08:TPF18
Lane 09:TPF19
Lane 10: pBR322DNA/Msp I Digest

Profile of microsatellite loci Pmarg7 amplified in *P. fucata* samples using primer Pmarg7F&R from *P. margaritifera*



PCR confirmation of the presence of transgene in embryo, lane 1-4 negative, lane 5 confirmed

Transgenic *D. rerio* embryo @ 48 h.

The GFP-transgene construct was used for transformation of *Danio rerio* embryo at 2-4 cell stage by electroporation. Transgenic *D. rerio* embryo expressing GFP was obtained, the integration of the gene was confirmed using PCR with specific primers. The transgenic embryos were viable for 48 hours.

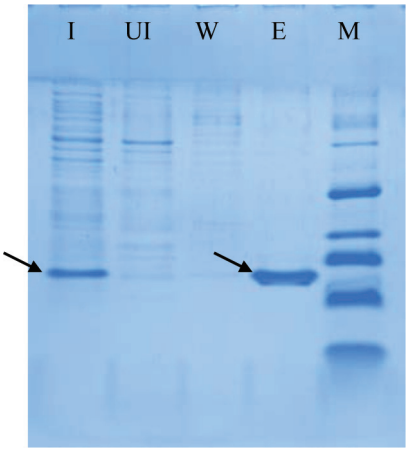
Molecular cloning and recombinant expression of Gonad Inhibiting Hormone (GIH) from *Penaeus monodon*

Aimed at deriving an alternative way to induce growth and ovarian maturation without eyestalk ablation in *Penaeus monodon,* molecular and functional aspects of the Gonad Inhibiting Hormone (GIH) was investigated in the species.

Recombinant expression of GIH gene

Primers were designed for directional insertion of mature peptide coding region encoding PmGIH into pET-28b Expression vector (Novagen, USA) for recombinant expression of PmGIH along with a fused 6xHIS tag at the *C terminus*. The recombinant pET-28b-PmGIH plasmid was used to transform *E. coli* ER2566 competent cells (NEB) and transformed colonies were selected for expression studies by IPTG induction.

The 6xHis-tagged rPmGIH protein was affinity purified using the Ni-NTA Fast Start Kit (QIAGEN®) under denaturing conditions. Bound 6xHis-tagged protein was eluted into denaturing elution buffer and was subjected to 15% Tricine SDS polyacrylamide gel electrophoresis (Tricine SDS PAGE) under reducing conditions to detect the presence of recombinant protein.



I – Induced cells
UI – Uninduced cells
W – Wash
E – Elute (Purified rPmGIH)
M – Protein molecular weight marker
Arrow heads indicates the protein band of expressed rPmGIH protein
Vector – pET28; Host – *E. coli* ER2566
Product size ~10kda

Tricine SDS-PAGE analysis of the rGIH expression

Bioprospecting of genes and allele mining for abiotic stress tolerance from marine microalage

Microalgae collection and maintenance

Phenotypic and genotypic identification of 20 new isolates of marine microalgae were carried out during the period, and added to the NAIP-CMFRI National Facility for Marine Micro Algae (NFMA). Morphological (color of culture, cell size, shape, cell inclusions, flagellar organisation, movement patterns of the organism *etc.* by microscopic examination) and molecular (18S rDNA, rbcL, CO1 and ITS genes) techniques were employed to identify and characterise the isolates. At present, a total of 144 pure isolates of marine microalgae representing different habitats of Indian coast (isolated from 47 locations including the salt pans in Gulf of Kutch, Odisha, Andra Pradesh, Tamil Nadu, Goa and hot springs in Himachal Pradesh) are being maintained at the NFMA. A database depicting all relevant information of these microalgal isolates including morphological, anatomical, biochemical and molecular features is created and maintained.

Twenty two new sequences (including rbcL and ITS gene sequences - for molecular taxonomic applications) were submitted to NCBI GenBank database (GenBank Accessions JN797799 to JN797820).

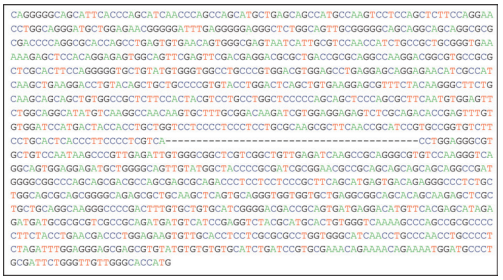
Characterisation of stress tolerant genes in marine algae

Carried out complete characterisation of 4 genes conferring tolerance to high salinity *viz*., chloroplast lycopene beta-cyclase (LCYB) from *Dunaliella salina,* 2-Cys peroxiredoxin (Prx2) and duplicated carbonic anhydrase (DCA1) from *Dunaliella viridis* and trehalose-6-phosphate synthase (TPS) from *Dunaliella viridis* and *Dictyosphaerium ehrenbergianum.*

A total of 9 sequences (including HDR, LCYB, Prx2, DCA1, TPS, PSY and desD gene sequences, conferring tolerance to hyper saline conditions) were submitted to NCBI GenBank database.

Trehalose-6-phosphate synthase (TPS) gene

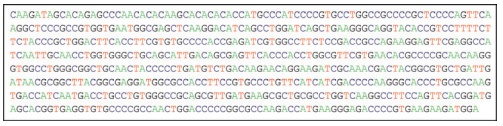
Trehalose has functional properties related to energy metabolism and protection in extreme environmental conditions. The full length (complete CDS) TPS gene (~2931 bp) was amplified from *D. viridis* (isolate MBTD-CMFRI-S122) and *Dictyosphaerium ehrenbergianum* (isolate MBTD-CMFRI -S129) cDNA using the newly designed primers. This amplified product has been cloned into pJET1.2 cloning vector. The cloned product was then completely sequenced (1960 bp) using the vector specific primers and further by primer walking.



Trehalose-6-phosphate synthase (TPS) gene complete CDS (~2931 bp) DNA sequence information generated from *Dunaliella viridis*

2-Cys peroxiredoxin (Prx2) gene from *Dunaliella viridis*

The function of peroxiredoxin is to protect the photosynthetic membrane against photooxidative damage. The full length (complete CDS) Prx2 gene (~722 bp) was amplified from *Dunaliella viridis* (isolate MBTD-CMFRI-S122) cDNA using the newly designed primers. This amplified product has been cloned into pJET1.2 cloning vector. The cloned product was then sequenced completely (722 bp) using the vector specific primers and further by primer walking.



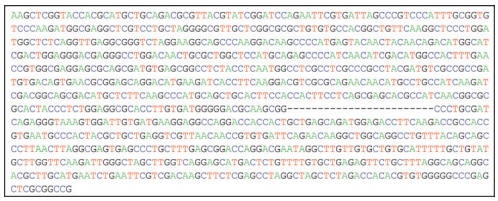
2-Cys peroxiredoxin (Prx2) gene complete CDS (~722 bp) DNA sequence information generated from *D. viridis*.

Allele mining: Details of gene sequence information generated

Species	Stress	Gene(s) (sequence information)	No. of germplasm lines used	Sequence submission (Acc.No.)
Dunaliella salina and *Dictyosphaerium ehrenbergianum*	Salinity	4-Hydroxy-3-methylbut-2-enyl diphosphate reductase (HDR) (Complete CDS amplified, cloned and expressed in E. coli)	2	JQ762450 JQ762456
Dunaliella viridis	Salinity	2-Cys peroxiredoxin (Prx2) (Complete CDS amplified, cloned and expressed in E. coli)	1	JQ762455
D. viridis and *Dictyosphaerium ehrenbergianum*	Salinity	trehalose-6-phosphate synthase (TPS) (Complete CDS amplified and cloned)	2	JQ762453 JQ762454
Dunaliella viridis	Salinity	duplicated carbonic anhydrase (DCA1) (Complete CDS amplified and cloned)	1	JQ762452
Dunaliella salina	Salinity	chloroplast lycopene beta-cyclase (LCYB) (Complete CDS amplified and cloned)	1	JQ762457
Dunaliella sp.	Salinity	Phytoene synthase (PSY)	1	JQ762451
Artrospira platensis	Salinity	Desaturase-D (des D)	1	JQ762449

Duplicated carbonic anhydrase (DCA1) gene from *Dunaliella viridis*

Carbonic anhydrase is a salt induced gene that has a physiological role to increase the availability of CO_2 in saline media where the availability of CO_2 is greatly diminished. The full length (complete CDS) DCA1 gene (~1849 bp) was amplified from *D. viridis* (isolate MBTD-CMFRI-S122) cDNA using the newly designed primers. This amplified product has

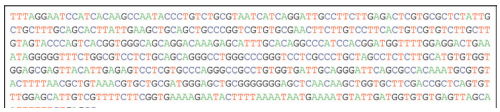


Duplicated carbonic anhydrase (DCA1) gene complete CDS (~1849 bp) DNA sequence information generated from *Dunaliella* sp.

been cloned into pJET1.2 cloning vector. The cloned product was then sequenced completely (1849 bp) using the vector specific primers and further by primer walking.

Chloroplast lycopene beta-cyclase (LCYB) gene from *Dunaliella salina*

Lycopene beta-cyclase is responsible for a high level of beta-carotene accumulation in *Dunaliella,* and it helps in salinity tolerance. The full length (complete CDS) LCYB gene (~1800 bp) was amplified from *Dunaliella salina* (isolate MBTD-CMFRI-S089) cDNA using the newly designed primers. This amplified product has been cloned into pJET1.2 cloning vector. The cloned product was then completely sequenced (1817 bp) using the vector specific primers and further by primer walking.



Chloroplast lycopene beta-cyclase (LCYB) gene complete CDS (1817 bp) DNA sequence information generated from *Dunaliella salina*

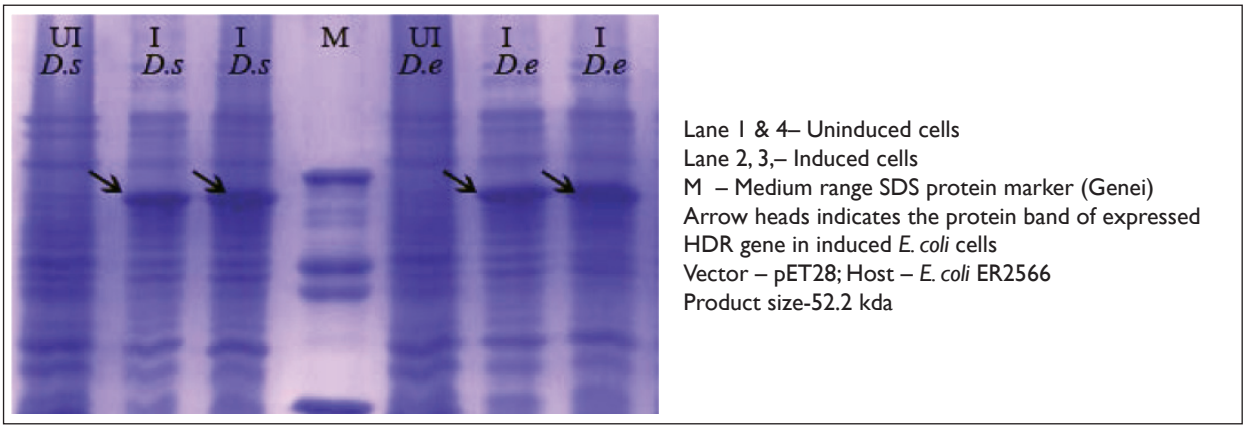
Functional validation of HDR and Prx2 genes

The genes such as HDR and Prx2 were functionally validated by recombinant expression in *E. coli.* The clones of these genes are now available for any transgenic experiments.

Gene	Trait	Species in which validation done: plant/*E. coli*/yeast
4-Hydroxy-3-methylbut-2-enyl diphosphate reductase (HDR)	Salinity and nutrient depletion	*E. coli*
Cys peroxiredoxin (Prx2)	Salinity / oxidative stress	*E. coli*

HDR gene

The completely characterised 4 - Hydroxy - 3 - methylbut - 2 - enyl diphosphate reductase (HDR) gene from *D. salina* has been recombinantly expressed in *E. coli.*

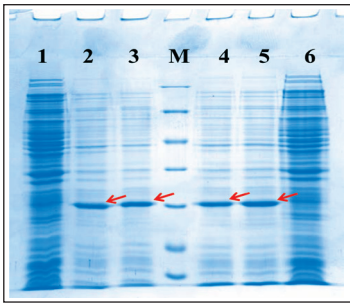


Lane 1 & 4– Uninduced cells
Lane 2, 3,– Induced cells
M – Medium range SDS protein marker (Genei)
Arrow heads indicates the protein band of expressed HDR gene in induced *E. coli* cells
Vector – pET28; Host – *E. coli* ER2566
Product size-52.2 kda

Expression profile of HDR gene on 10% SDS-PAGE.

Prx2 gene

The function of peroxiredoxin is to protect the photosynthetic membrane against photooxidative damage. The full length (complete CDS) Prx2 gene (~722 bp) was amplified from cDNA using specific primers, cloned, sequenced and characterised. The completely characterised 2-Cys peroxiredoxin (Prx2) gene from *D. viridis* has been recombinantly expressed in *E. coli.*



Lane 1 & 6 – Uninduced cells
Lane 2, 3, 4 & 5 – Induced cells and
M – Unstained protein molecular weight marker (Fermentas)
Arrow heads indicates the protein band of expressed HDR gene in induced *E. coli* cells
Vector – pET28; Host – *E. coli* ER2566
Product size ~25 kda

Expression profile of Prx2 gene on 10% SDS-PAGE.

Details of Gene / DNA sequence submissions

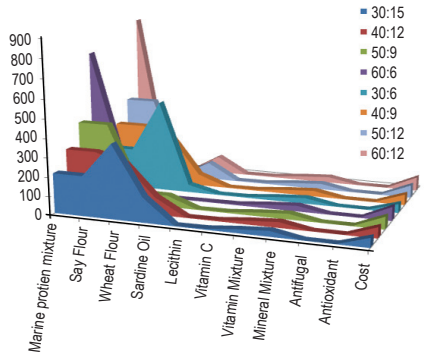
GenBank Acc. No.	Gene / DNA sequence definition
Preetha, K., Vijayan, K.K., Pradeep, M.A., Subin, C.S., Lijo, J., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762449	*Arthrospira platensis* strain MBTD-CMFRI-S016 delta 6 desaturase (desD) gene partial sequence
Vijayan, K.K., Lijo, J., Subin, C. S., Preetha, K., Pradeep, M. A., Srinivasa Raghavan, V. and Thomas, P. C.	
JQ762450	*Dunaliella salina* strain MBTD-CMFRI-S089 4-hydroxy-3-methylbut-2-enyl diphosphate reductase (HDR) gene complete cds
Pradeep, M.A., Vijayan, K.K., Lijo, J., Preetha, K., Subin, C.S., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762451	*Dunaliella* salina strain MBTD-CMFRI-S089 phytoene synthase (PSY) gene partial sequence
Pradeep, M.A., Vijayan, K.K., Subin, C.S., Lijo, J., Preetha, K., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762452	*Dunaliella viridis* strain MBTD-CMFRI-S122 duplicated carbonic anhydrase (DCA1) gene complete cds
Vijayan, K.K., Pradeep, M.A., Subin, C.S., Lijo, J., Preetha, K., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762453	*Dunaliella viridis* strain MBTD-CMFRI-S122 trehalose-6-phosphate synthase/phosphatase (TPS) gene complete cds
Subin, C.S., Vijayan, K.K., Preetha, K., Pradeep, M.A., Lijo, J., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762454	*Dictyosphaerium* sp. strain MBTD-CMFRI-S129 trehalose-6-phosphate synthase/phosphatase (TPS) gene complete cds
Subin, C.S., Vijayan, K.K., Pradeep, M.A., Lijo, J., Preetha, K., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762455	*Dunaliella viridis* strain MBTD-CMFRI-S122 2-Cys peroxiredoxin (Prx2) gene complete cds
Lijo, J., Vijayan, K.K., Subin, C.S., Pradeep, M.A., Preetha, K., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762456	*Dictyosphaerium* sp. strain MBTD-CMFRI-S129 4-hydroxy-3-methylbut-2-enyl diphosphate reductase (HDR) gene partial sequence
Lijo, J., Vijayan, K.K., Subin, C.S., Preetha, K., Pradeep, M.A., Srinivasa Raghavan, V. and Thomas, P.C.	
JQ762457	*Dunaliella salina* strain MBTD-CMFRI-S089 chloroplast lycopene beta-cyclase (LCYB) gene partial sequence

The Suppression Subtractive Hybridization (SSH) studies with Dunaliella sp.

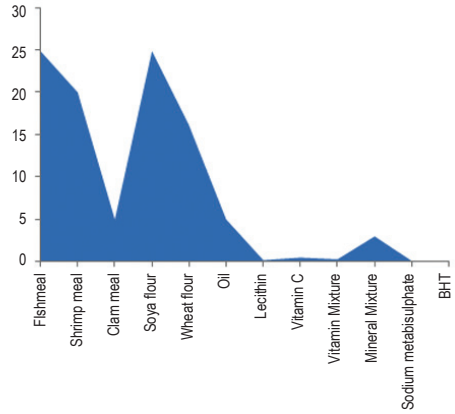
Isolated 480 more clones from Dunaliella sp. (isolate S-89) SSH library and sequenced 100 more clones. Partially characterised 16 genes including 3 novel genes (not reported so far, some hypothetical proteins) from Dunaliella sp. (isolate S-89) SSH library (under salinity stress), which might be conferring tolerance to the survivability of microalgae under hyper saline conditions.

BLAST analysis of sequenced clones showed similarity with genes such as : fructose - 1, 6 - bisphosphatase (FBP), glyceraldehyde 3 - phosphate dehydrogenase (GAPDH), 2-oxoglutarate-dependent dioxygenase (AOP), aspartic protease, 60S Ribosomal protein, glyoxysomal malate dehydrogenase, outer membrane porin protein LC/IS10 transposase, alkaline-phosphatase like protein, chloroplast ATP sulfurylase 1 (ATPS1), nine-cis-epoxycarotenoid dioxygenase 4 (NCED4), late expression factor 8 (lef-8) gene, photosystem II polypeptide (PSBR)/hypothetical protein, NaCl inducible and photosystem II light harvesting complex protein. Some hypothetical protein and few clones showed no significant similarity.

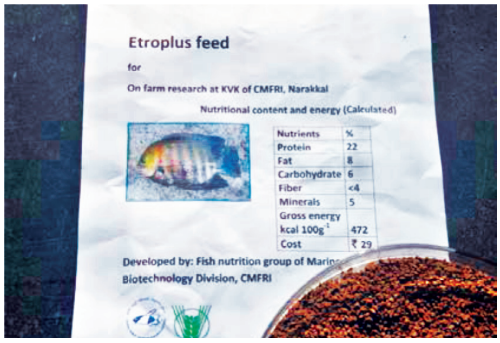
Fish Nutrition



Feeds formulated with varying protein-lipid combinations for evaluation in pompano



Percentage ingredient composition of nursery feed of seabass



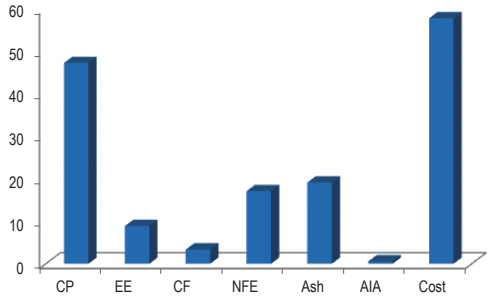
Formulated feed development for cage cultured finfishes

Feed development for Pompano *(Trachynotus blochii)*

Taking into consideration the high energy requirement reported for pompano *(Trachynotus blochii),* eight feeds were designed and produced for evaluation in the species. The feed design formulation was based on permutations and combinations of protein and fat requirements. Out of the formulations, only four feeds containing wheat flour could be extruded (30: 15, 40: 12 and 30: 6 and 40: 9). Other feeds had to be hand pelletised due to the absence of starchy material. Physical and nutritional evaluations are being carried out.

Formulated feed for seabass *(Lates calcarifer)* nursery rearing

Nursery feeds for Asian seabass *(Lates calcarifer)* were designed and extruded to be used in the low cost cage rearing of seabass to replace the existing trash fish feeding regime with a dry pellet feed to ensure cost effectiveness. The field trials of the experimental feeds are progressing at Mangalore and Cochin.



Proximate composition (% dry matter basis) and cost (₹) of nursery feed for seabass

On-farm evaluation of cost effective feeds in pearl spot *(Etroplus suratensis),* in association with KVK Narakkal

For on-farm evaluation of cost effective feeds for pearl spot were conducted in association with KVK of CMFRI, Narakkal and another feed was formulated and produced in the experimental feed mill.

Alternative plant protein source for fishmeal replacement

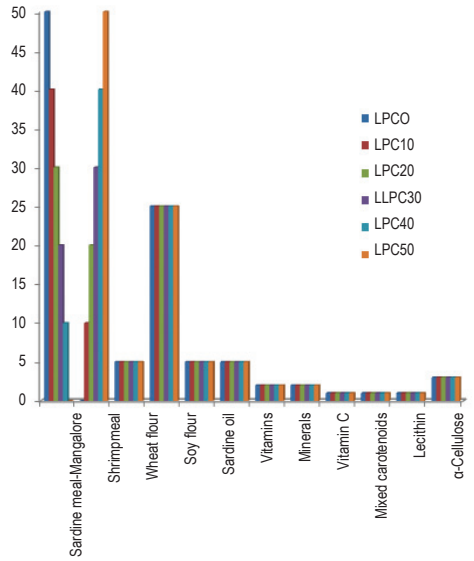
In an effort to find a suitable replacement for fish meal, a sustainable alternative from a locally available and cheap source of leaf protein (~50% protein) reported by CTCRI, Trivandrum has been taken up for fish meal substitution in formulated feeds.

Cassava leaf protein concentrate (LPC) was incorporated in ornamental fish feeds and evaluated for its propensity to replace fish meal. The proximate composition, amino acid content and fatty acid content of LPC are depicted in the Tables below. Crude fat content was found to be high in this ingredient in which 16:00 (palmitic acid) was found to be the dominant fatty acid amongst the saturates. Among the amino acids, lysine was found to be high which merits its consideration as a fish feed ingredient. LPC was incorporated at 0, 10, 20, 30, 40 and 50% levels replacing fish meal in the formulations.

In a series of six isoproteic (38%) and isocaloric feeds (17-20 MJ kg-1), fish meal content varied from 0 to 50% which was replaced with LPC at 10 % intervals as shown in the Figure.

Proximate composition of the formulated feeds designated LPC0 to LPC50 indicating the levels of fish meal replacement with LPC are also presented in the Figure. Amino acid content of these feeds were also profiled.

As a preliminary nutritional evaluation, black molly (Poecilia sphenops) a popular freshwater ornamental fish was chosen as the model fish for testing the acceptability of feeds containing LPC and the resultant growth and longevity. Limited availability of LPC and small requirement of fish feed also favours the choice of an ornamental fish for experimentation. Black mollies of uniform size (200 ± 15 mg) were acclimatised to the experimental conditions which consisted of 18 glass aquaria (50 l each) in a recirculation system with biological filters. Feeds were produced in a twin-screw extruder (BTPL, Kolkota) with a time temperature combination for slow sinking pellets of 2 mm diameter which were crushed and sieved to 0.75 mm which is the size appropriate for feeding these fish. At the end of six weeks the acceptability of the feeds were good and growth was found to be higher in all the treatments with LPC10 registering the maximum weight gain. The higher weight gain over a control feed (commercial shrimp feed) and the capability of LPC to replace fish meal are quite promising to take up this plant protein for further comprehensive investigations. The nutritional trial is continued for further testing and refinement.



Pecentage ingredient composition of experimental feeds substituting fish meal with leaf protein concentrate (LPC)

Proximate composition (% dry matter basis) of cassava leaf meal (LM) and leaf protein concentrate (LPC)

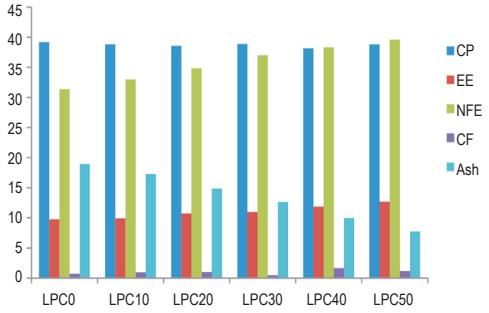
	Protein	Fat	Carbohydrate	Fiber	Ash	AIA
Analysis at CTCRI						
LPC	55-60	4.50	20.00	6.00	5.00	
LM	22-30	5.00	40.00	6.00	8.00	
Analysis at CMFRI						
LPC	41-48	16-24	31-40	1.2	3-4	0.22-0.55
LM	30	9	39	16	4	0.23

Amino acid content in cassava leaf protein concentrate (LPC)

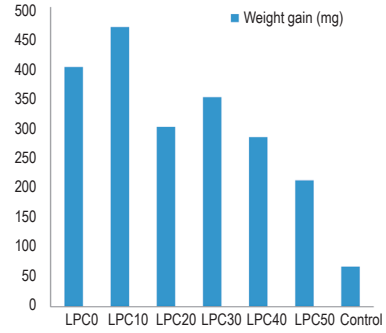
Amino acids	% of protein	Amino acids	% of protein
Asp	7.50	Tyr	3.37
Glu	8.19	Val	6.69
Ser	5.13	Met	1.25
Gly	9.40	Cys	0.21
His	1.88	Ile	5.26
Arg	4.74	Leu	9.68
Thr	5.17	Phe	4.88
Ala	8.15	Lys	11.31
Pro	6.01		

Fatty acid profile of cassava leaf protein concentrate (LPC) and leaf meal (LM)

Fatty acid composition	Fat %	
	LPC	LM
2:00	0.28	1.92
4:00	1.60	3.9
Iso 4:0	nd	0.95
6:00	0.58	0.72
iso 6:0	nd	0.55
8:00	0.25	0.38
12:00	4.62	2.15
14:00	3.19	4.09
15:00	0.11	0.07
16:00	32.40	24.59
17:00	0.53	0.85
18:00	6.08	5.11
24-0	2.18	1.09
ΣSFA	51.82	46.37
16:01	4.21	3.15
18:01	27.62	21.17
24:01:00	0.29	1.52
ΣMUFA	32.12	25.84
Cis-18:2n6	11.37	19.28
Cis-18:3n6	0.06	0.86
18:3n3	0.05	1.46
18:4n3	0.08	0.52
C20:2n6	0.25	0.33
C20:3n6	nd	0.74
C20:4n6	nd	0.09
20:5n3	nd	0.05
22:5n3	nd	0.01
22:6n3	nd	nd
ΣPUFA	11.81	23.34



Proximate composition (% dry matter basis) of LPC incorporated diets



Weight gain in blackmollies in six weeks

Amino acid content in LPC incorporated feeds (% of protein)

Amino acids	LPC0	LPC10	LPC20	LPC30	LPC40	LPC50
Asp	6.14	5.54	6.42	7.10	7.45	6.73
Glu	10.59	10.24	9.74	9.21	10.91	9.22
Ser	4.71	5.29	4.15	4.99	5.00	5.20
Gly	12.23	12.34	11.76	11.33	10.13	10.57
His	1.99	1.93	1.72	1.56	1.82	1.60
Arg	4.93	5.28	4.16	5.20	4.93	4.77
Thr	4.33	4.32	3.86	4.86	4.58	4.91
Ala	8.24	8.29	8.62	9.62	8.50	8.08
Pro	7.25	8.00	8.91	6.67	6.53	7.80
Tyr	2.71	3.18	3.34	3.56	2.92	2.85
Val	5.29	5.09	5.71	6.70	5.88	5.94
Met	2.20	2.19	1.59	1.60	1.77	1.12
Cys	0.44	0.41	0.10	0.37	0.33	0.40
Ile	4.50	4.18	4.84	5.54	4.77	4.85
Leu	8.05	8.95	9.11	8.88	8.84	9.47
Phe	4.24	4.11	4.91	4.38	4.31	5.05
Lys	11.23	9.46	10.08	7.60	9.76	10.26

Sand lobster nutrition

A wet feed comprising of bivalves, cephalopods and sardine were tested in sand lobster. The feed was accepted with encouraging growth rates. Experiments are being continued for validation of nutrient profile and growth data.

Feed material	Growth and survival	Remarks
Clams *Meretrix casta* *Donax cuneatus*	Highest	Estuarine clam *(Meretirix casta)* exhibits better growth than *Donax*
Cephalopods	Good growth up to first moult	Significantly higher loss of weight at moulting
Sardines	Lowest	Probably due to nutrient deficiencies

Preparation of microalgal oil concentrates

The experimental microalgae selected in this study belonged to the family prymnesiophytes *(viz., Pavalova viridis* and *Isochrysis galabana)* and eustigmatophytes *(viz., Nannochloropsis oculata* and *Chaetoceros calcitrans)*, and the stock of the microalgae culture required for the study were sourced from the NAIP-CMFRI National Facility for Marine Micro Algae (NFMA), Cochin. These species were cultured under circadian light: dark cycle at a temperature of 23 °C. Each culture flask contained culture medium, prepared with seawater (35‰) enriched with nutrients. The microalgal cultures were grown up to stationary phase and further mass cultured. The cell density was assessed daily in the harvested cultures by microscope cell counting using a haemocytometer. Microalgal species were concentrated and extracted with suitable solvents followed by acidification under inert atmosphere. Lipid and fatty acid contents were estimated following the method reported by Bligh and Dyer (1959) with suitable modifications. The esterified fatty acid content was analysed by gas liquid chromatography. The microalgal concentrate will be evaluated in finfish larval rearing experiments.

Lipid content of selected microalgal species

Algae	Lipid (%) (wet weight basis)
Isochrysis galabana	6.03%
Pavlova viridis	2.71%
Nanochloropsis oculata	2.27%

Fatty acid profile of microalgae to be used to formulate microalgal powder

Fatty acids	*Pavalova viridis*	*Isochrysis galabana*	*Nannochloropsis oculata*	*Chaetoceros calcitrans*
14:0	13.24	13.44	7.22	15.82
15:0	2.08	3.15	1.46	1.30
16:0	10.21	10.74	34.80	11.72
17:0	0.11	2.15	0.28	0.30
18:0	0.59	0.59	1.08	8.41
20:0	0.45	1.23	0.54	0.70
22:0	1.02	0.55	0.89	2.10
24:0	0.18	0.27	0.03	0.90
SFA	**27.87**	**32.13**	**46.30**	**41.26**
14:1n7	0.11	0.27	0.07	0.40
15:1	1.93	3.06	1.80	0.20
16:1ω7	5.42	6.35	20.07	3.71
18:1n7	0.07	0.27	0.12	0.70
18:1ω9	15.06	14.85	6.92	1.60
20:1	0.59	0.23	0.03	0.10
22:1	0.86	0.23	3.10	1.00
24:1	0.41	0.46	0.14	0.20
MUFA	**24.45**	**25.73**	**32.25**	**7.91**
18:2n6 cis	10.72	8.82	3.33	4.41
18:3n6	5.04	5.53	0.42	4.51
18:3ω3	0.55	0.23	0.59	0.30
20:2n6	14.74	11.65	0.35	6.11
20:3n6	0.14	0.37	0.16	7.71
20:4ω6	0.73	0.73	0.37	7.71
20:5ω3	0.98	2.10	11.23	8.81
22:2n6	0.39	0.50	0.14	0.10
22:5n3	1.47	1.10	0.58	5.41
22:6ω3	6.33	7.13	0.45	4.31
PUFA	**41.11**	**38.16**	**17.61**	**49.37**

Fatty acid profile of native *Tetraselmis* strains (Prasinophyceae) isolated from Indian subcontinent

Among the many important microalgal live feeds, *Tetraselmis* sp. is widely used for hatchery rearing of larval shrimps, prawns, bivalves *etc*. Nutritional value of microalgae depends on polyunsaturated fatty acids (PUFAs), particularly the n-3 PUFAs such as EPA and DHA. Lipid and fatty

Fatty acid composition of native *Tetraselmis* strains (Prasinophyceae)

	Fatty acids (% Total fatty acids)					
Fatty acids	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
∑ SFA	26.08	27.44	28.36	30.46	13.93	32.23
∑ MUFA	8.72	9.17	9.41	13.6	20.45	16.66
18:2n6	15.67	14.30	8.72	11.13	2.96	4.78
18:3n6	2.58	18.64	10.23	0.80	0.35	7.32
18:3n3	15.24	4.93	6.51	12.91	11.14	10.80
20:2n6	11.92	1.84	0.81	3.16	0.96	0.58
20:3n6	0.30	0.87	0.47	4.76	0.78	0.07
20:4n6	0.13	1.35	1.86	0.92	0.52	0.29
20:5n3	8.39	12.46	12.44	8.67	14.89	15.07
22:5n3	0.39	1.35	1.05	0.57	1.04	0.43
22:6n3	1.55	4.93	6.16	3.10	8.45	10.36
Others	2.58	1.45	8.37	4.36	ND	ND
∑ PUFA	58.75	62.12	56.62	50.38	41.09	49.7

T1-T6 are signified as *Tetraselmis* sp.
∑ SFA: total saturated fatty acid; ∑ MUFA: total monounsaturated fatty acid ∑ PUFA : total monounsaturated fatty acid.

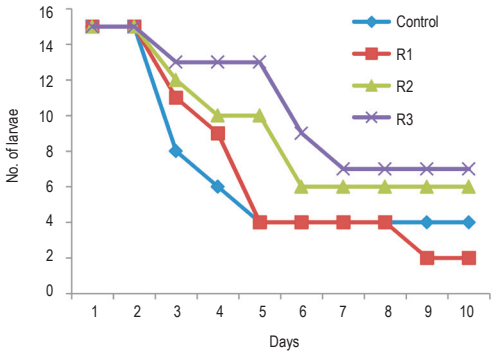
acid composition of five strains of *Tetraselmis* isolated from Indian coast were studied for fatty acid composition. Considerable amount of lipid and fatty acids were found in all isolates with lipid content ranging from 4.13-20% and total PUFAs ranging from 41-62%. EPA was found to be 8.4-15%, and DHA 1.6-10.4%. The essential fatty acid, linoleic acid was found in good quantities (3-16%). The isolates thus found to have potential use for animal health in captive mariculture.

Exploration of seaweeds for possible feed enrichment products

Two seaweeds *Sargassum longifolium* and *Gracilaria edulis* were collected from Mandapam coast for the exploration of possible products for feed enrichment/nutraceuticals. They were washed, shade dried and powdered to get dry powder of 870 g and 200 g respectively. As the first step, isolation of alginic acid and agar was done from *S. longifolium* and *G. edulis* adopting standard procedures. Crude alginic acid (4.6 g, 9.2%) was obtained from 50 g of *S. longifolium* by standard calcium salt method and 9 g of agar from 50 g of *G. edulis* (18% yield) by standard freeze thaw method. Quantitative isolation of these two products from more quantity of respective seaweeds is in progress. A simple method was evolved to prepare bleached sodium alginate from the brown seaweed, *S. longifolium*.

Evaluation of live feed enrichment emulsion (LFEE)

The live feed enrichment emulsion (LFEE) developed by CMFRI was evaluated in order to standardise the protocols. In the current experiment, *Amphiprion ocellaris* larvae were reared on enriched emulsion prepared. The experiment revealed the potential of using LFEE as an indigenous replacement in finfish larviculture systems.



Larval survival in clownfish with DHA enriched rotifers

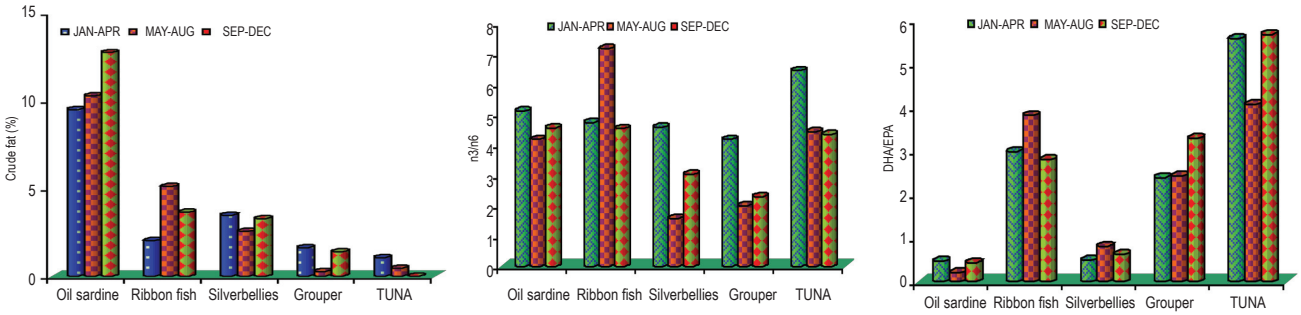
Nutrient profiling and evaluation of fish as a dietary component

Examination of the seasonal changes in proximate composition, fatty acid, amino acid, vitamins and minerals of the selected fish species *viz.*, *Sardinella longiceps* (oil sardine), *Katsuwonus pelamis* (skipjack tuna), *Trichiurus lepturus* (ribbonfish), *Leiognathus splendens* (silverbelly), *Epinephelus diacanthus*/ *Epinephelus merra* (grouper) revealed the nutritional status.

Fat

The differential composition of crude fat of five candidate marine fish species collected in three different seasons were evaluated.

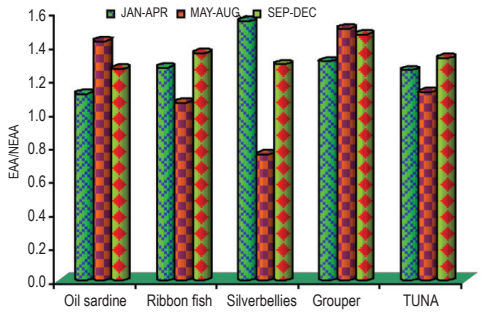
The *n*-3/*n*-6 fatty acid ratio of different marine fish species were found to be >2, which is considerably higher than the health foods available in the market, and therefore they may serve as an effective alternative to balance the higher intake of *n*-6 fatty acids.



Differential composition of n3/n6 fattyacids and DHA/EPA ratios of five candidate marine fish species collected during three different seasons

Amino acids

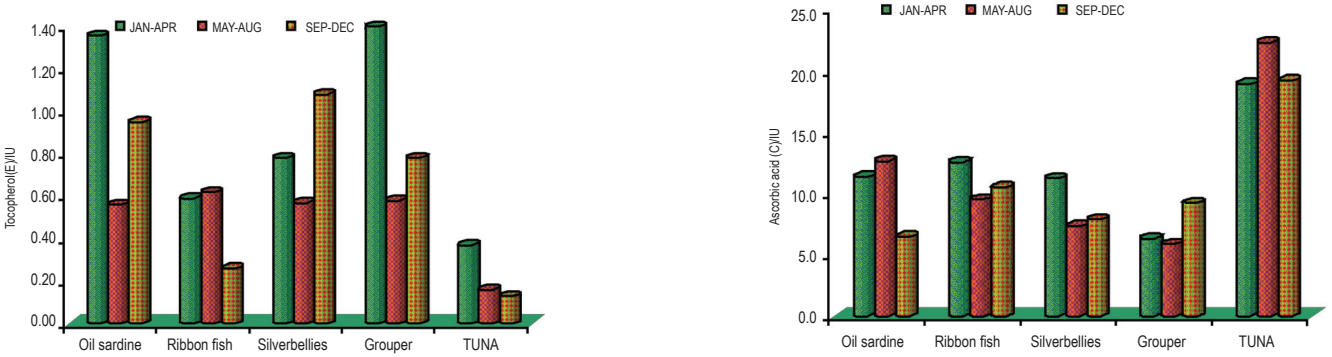
The differential composition of EAA/NEAA ratio of five candidate marine fish species showed that they have well balanced and high-quality protein source in respect of E/NE ratio. Any ratio of E/NE amino acids higher than 1.0 is considered to be excellent, and therefore it can be concluded that, marine fish species are good sources of well balanced proteins and high quality protein source in respect of E/NE ratio.



Differential composition of essential to non-essential amino acid ratios (EAA/NEAA) of five candidate marine fish species

Vitamins

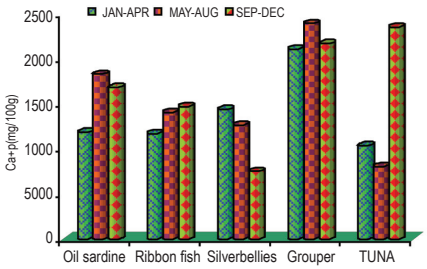
Analysis of tocopherol and ascorbic acid in five marine fin fish species collected during three different seasons indicated that marine fishes are good sources of these vitamins



Tocopherol and ascorbic acid levels in five marine finfish species collected during three different seasons

Minerals

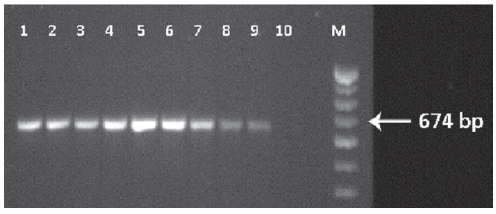
The differential composition of Ca + P and Se of five candidate marine fish species collected in three different seasons were evaluated. Among different marine fish species grouper (2109 - 2395 mg/100 g) recorded highest calcium-phosphorus content and silverbelly (751.5 mg/100 g) recorded very low calcium-phosphorus content.



Ca + P and Se composition of five marine finfish species collected during three different seasons

Fish Health and Bioprospecting

Host range of *Perkinsus* spp.	Geographical location
Oysters	
Crassostrea madrasensis	Goa, Kannur, Thalassery, Calicut, Cochin, Kollam, Tuticorin
Saccostrea cuculata	Azhikode, Calicut
Pinctada fucata	Tuticorin
Pinctada margaritifera	Andaman & Nicobar islands
Isognomon sp.	Calicut
Mussels	
Perna indica	Kollam, Kannur,
Perna virdis	Dharmadam, Thalassery, Calicut
Pinna bicolor	Tuticorin
Clams	
Meretrix casta	Calicut
Geloina bengalensis	Azhikode
Paphia malabarica	Calicut, Tuticorin
Donax sp.	Azhikode
Anadara granosa	Dharmadam



Gell image of amplified PCR products using *Perkinsus* genus specific ITS 85 and ITS 750 primers

Pathogen profiling, diagnostics and health management in maricultured finfish and shellfish

Epidemiological studies on *Perkinsus olseni*

Subsequent to the report of the OIE listed protozoan, *Perkinsus olseni,* in pearl oysters *(Pinctada fucata)* from the southeast coast of India for the first time, epidemiological studies were taken up to undersatnd the host range. The study conducted using Rays Fuid Thioglycollate Medium (RFTM) assay along with first and second step PCR revealed that *Perkinsus* spp. enjoyed a very wide host range in the region. *Perkinsus* infections were observed in a total of 13 bivalve host species from various habitats along the Indian subcontinent.

First report of *Perkinsus beihaiensis* and another species of *Perkinsus* similar to *P. beihaiensis* from the Indian waters

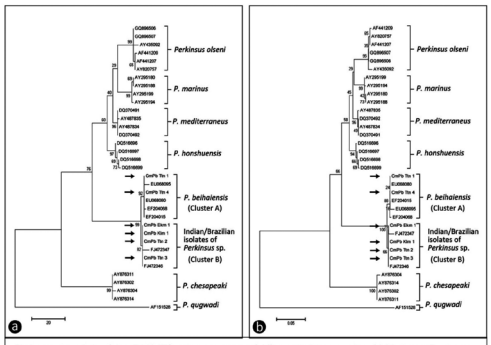
During the epidemiological study, tissue samples collected from bivalve hosts across various regions were studied using conventional and molecular diagnostic techniques. PCR screening of the tissues using the *Perkinsus* genus specific Internal Transcribed Spacer (ITS) 85 and ITS 750 primers, amplified the product specific to the genus *Perkinsus* (ca. 700 bp). The sequencing of the amplified PCR products and blast analysis of *Perkinsus* spp. from *Crassostrea madrasensis* along the southeast and southwest coasts of India showed 98-100% identity to *Perkinsus* sp. including *P. beihaiensis* and the Brazilian *Perkinsus* sp. with 96-100% query coverage (E value = 0).

Further detailed analysis and sequencing of the ITS and Actin genes of this parasite using PCR products were carried out. Products of actin gene from 4 samples were purified, cloned into pJET 1.2/blunt Cloning Vector using CloneJET PCR Cloning Kit and transformed into chemically competent *Escherichia coli* cells. The positive clones with expected size PCR amplifications were sequenced using pJET1.2 forward and pJET1.2 reverse primers. Approximately 330 bp fragment of the type I actin gene was amplified using PerkActin1 130F and PerkActin1 439R primers for sequencing studies.

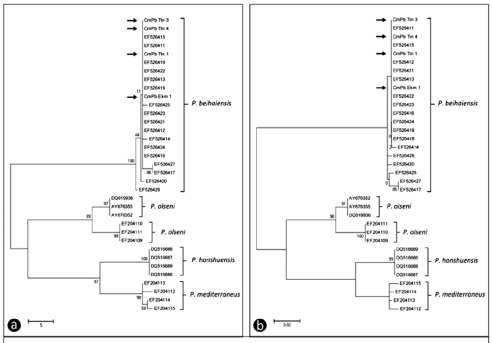
Based on Maximum Parsimony, Maximum Likelihood and Neighbor Joining analyses, the nucleotide sequences of the ITS region of the 6 samples studied were grouped under two closely related sister clades of *P. beihaiensis* and the Brazilian *Perkinsus* sp. described from China and Brazil respectively. The sequences of the 2 samples from the east coast (CmPb Ttn 1 and CmPb Ttn 4) were grouped with *P. beihaiensis* clade (Group A), while the other 4 samples; 2 from the east coast (CmPb Ttn 2 and CmPb Ttn 3) and 2 from west coast (CmPb Klm 1 and CmPb Ekm 1) were grouped with the Brazilian *Perkinsus* sp. clade (Group B) with 99 to 100% bootstrap support

during the phylogenetic analyses. The topologies of the trees generated with all the three analyses were similar. The sequencing of actin genes did not show any divergence among the samples studied and actin, being a nuclear protein coding gene and highly conserved within species, much intraspecific variations may not be expected.

The pairwise genetic distance values and phylogenetic analysis confirmed that two of the sequenced samples (Group A) belonged to the *P. beihaiensis* clade while the other four (Group B) showed close affinities with the Brazilian *Perkinsus* sp. clade. In spite of the absence of any geographical separation, and being in the same host species *(C. madrasensis)*, the Group B samples from India continued to form a separate cluster, exhibiting high similarity to the Brazilian *Perkinsus* sp. The pattern of geographic distribution, genetic divergence and phylogenetic data based on ITS sequence indicates that the Cluster B *Perkinsus* shows a very wide geographic range from the east coast of South America to the Indian subcontinent and could be an intraspecific variant of *P. beihaiensis* having a separate lineage, in the process of evolution. The study reports the presence of *P. beihaiensis* and another variant of *P. beihaiensis* for the first time in *C. madrasensis* populations from the Indian subcontinent and South Asia.



Phylogenetic analysis of the rDNA ITS region sequences of different *Perkinsus* species. (a) Maximum Parsimony analysis (b) Maximum Likelihood Analysis. Numbers at nodes show bootstrap values (%) for 1000 replicates. Arrows indicate the samples from the present study.



Phylogenetic analysis of the actin gene sequences of different Perkinsus species. (a) Maximum Parsimony analysis (b) Maximum Likelihood Analysis. Numbers at nodes show bootstrap values (%) for 1000 replicates. Arrows indicate the samples from the present study.

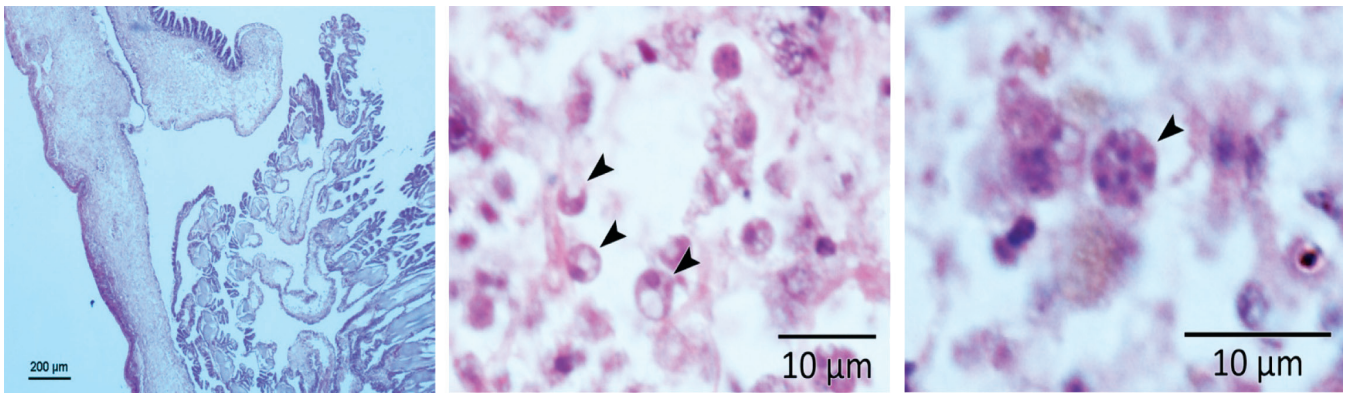
Histopathology of *Perkinsus beihaiensis* infection in *C. madrasensis:*

Histopathology studies showed positive results with trophozoite and developmental stages of *Perkinsus beihaiensis*. The parasite stages were mostly observed in the connective tissue, especially adjacent to the

The mean pairwise genetic distances between the various species of the genus *Perkinsus* based on the ITS sequences

	Present *Perk sp.(A)*	Present *Perk sp.(B)*	*P. bei*	*Brazilian Perk sp.*	*P. med*	*P. hon*	*P. mar*	*P. ols*	*P. che*	*P. qug*
Present *Perk sp.(A)*	***0.0***	0.0070	0.0023	0.0117	0.1099	0.1110	0.1266	0.1366	0.1841	0.4553
Present *Perk sp.(B)*		***0.0***	0.0094	0.0047	0.1070	0.1082	0.1236	0.1335	0.1776	0.4500
P. beihaiensis			***0.0047***	0.0141	0.1126	0.1138	0.1294	0.1390	0.1856	0.4587
Brazilian *Perkinsus sp.*				***0.0093***	0.1125	0.1137	0.1293	0.1393	0.1838	0.4520
P. mediterraneus					***0.0012***	0.0303	0.0359	0.0369	0.1405	0.3825
P. honshuensis						***0.0039***	0.0390	0.0545	0.1321	0.3803
P. marinus							***0.0027***	0.0481	0.1477	0.3637
P. olseni								***0.0045***	0.1541	0.3730
P. chesapeaki									***0.0023***	0.4141
P. qugwadi										--

The mean pairwise genetic distances estimated within the species are given across the diagonal



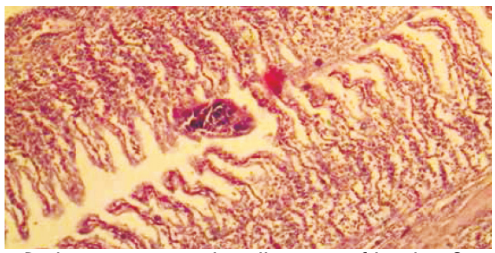
Histological sections showing the trophozoites of developing of *Perkinsus beihaiensis*

epithelial lining of the stomach, among the digestive tubules and in the muscle tissues along with schizonts in various stages of development and clusters of sibling trophozoites. Though, no apparent lesions were observed in the tissues, destruction of digestive tubules was evident in the samples examined. Irrespective of the status of infection, damage to digestive tubules was observed in 90.91% of the samples from Tuticorin while it was 50% in samples from Kollam which could be an indication of pollution in the Tuticorin waters.

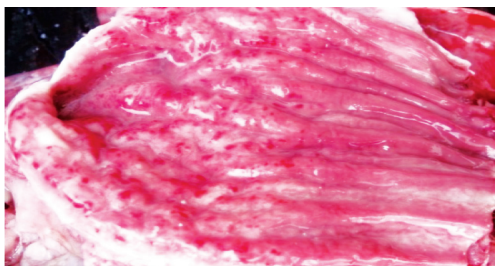
ITS and Actin gene sequence submissions of *Perkinsus* sp.

Authors: Sanil, N.K., Suja, G., Lijo, J. and Vijayan, K.K.

Sl.No	Gene/DNA sequence definition	Accession No.
1	*Perkinsus beihaiensis* isolate CmPb_Ttn_1 actin gene, partial cds	JN807331
2	*Perkinsus beihaiensis* isolate CmPb_Ttn_3 actin gene, partial cds	JN807332
3	*Perkinsus beihaiensis* isolate CmPb_Ttn_4 actin gene, partial cds	JN807333
4	*Perkinsus beihaiensis* isolate CmPb_Ekm_1 actin gene, partial cds	JN807334
5	*Perkinsus* sp. NKS-2011 isolate CmPb_Ekm_1 5.8S ribosomal RNA gene, partial sequence and internal transcribed spacer 2, complete sequence	JN054739
6	*Perkinsus* sp. NKS-2011 isolate CmPb_Klm_1 5.8S ribosomal RNA gene and internal transcribed spacer 2, partial sequence	JN054740
7	*Perkinsus beihaiensis* isolate CmPb_Ttn_1 internal transcribed spacer1, partial sequence; 5.8S ribosomal RNA gene and internal spacer 2, complete sequence and large subunit ribosomal RNA gene, partial sequence	JN054741
8	*Perkinsus* sp. NKS-2011 isolate CmPb_Ttn_2 5.8S ribosomal RNA gene, partial sequence; internal transcribed spacer 2, complete sequence; and large subunit ribosomal RNA gene, partial sequence	JN054742
9	*Perkinsus* sp. NKS-2011 isolate CmPb_Ttn_3 5.8S ribosomal RNA gene, partial sequence; internal transcribed spacer 2, complete sequence; and large subunit ribosomal RNA gene, partial sequence	JN054743
10	*Perkinsus beihaiensis* isolate CmPb_Ttn_4 5.8S ribosomal RNA gene, sequence; internal transcribed spacer 2, complete sequence; and large subunit ribosomal RNA gene, partial sequence.	JN054744



Diplectanum sp. in the gill tissues of *L. calcarifer*



Haemorrhages on the wall of stomach in cobia

PCR screening of *Lates calcarifer* for Nodavirus (VNN)

Considering the reports of Nodavirus (VNN) from the Indian stocks of *Lates calcarifer,* screening for the virus in the moribund, cage farmed *L. calcarifer* from Karwar was done using PCR. However, the results were negative, but could not be taken as conclusive considering the smaller sample size.

Monogenetic trematode infections in cage farmed *L. calcarifer*

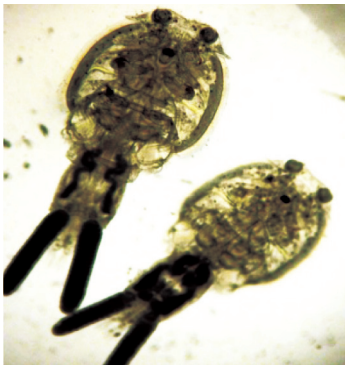
Heavy infestation with the monogenetic trematode parasite infection was observed among the cage farmed *L. calcarifer* at Karwar. The flukes were identified as *Diplectanum* sp. and histopathology studies revealed severe damage to the gill tissues.

Bacterial infections in cobia

Incidence of mortality in cobia broodstock at Mandapam was studied, necropsy revealed haemorrhages in stomach and histopathological studies showed marked tissue level damages including necrosis, indicating bacterial etiology.

Sea lice infestation in silver pompano

Infestation with the sea lice, *Calligus elongatus* was recorded among the silver pompano *(Trachynotus blochii)* broodstock reared at Mandapam. The affected fishes showed frequent surfacing and anorexia. The parasites caused physical and enzymatic damage at the sites of attachment resulting in lesions/ ulcers on the skin surface.



Sea lice from silver pompano

Luminescent *Vibrio harveyi* in the lobster larval rearing system

Incidence of mortality in the larval rearing system of *Thenus orientalis* at Kovalam was recorded. Studies conducted revealed the presence of the luminous bacterium *Vibrio harveyi* in the rearing water and phyllosoma larvae. Studies on the virulence status of the *V. harveyi* isolate is in progress.

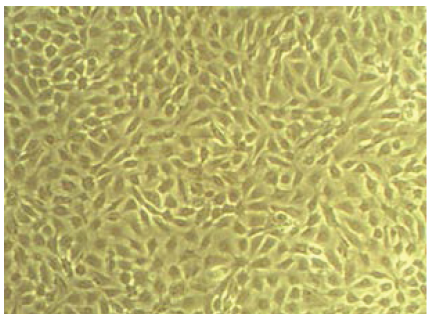
Bacterial infections in lobsters

Mortalities observed in lobsters *(Panulirus homarus)* at the captive holding facility at Kanyakuamari were investigated. The animals exhibited tail erosions, loss of walking legs and blackening and softness of joints of the appendages. Swelling and fluid accumulation in the area between the carapace and first abdominal segment was also evident. Four distinct bacteria were isolated from the infected lobsters and characterised using molecular methods. Gene sequence of one species *viz*., *Bacillus circulans* was deposited in GenBank (Acc No. JQ409560). Lobsters reared in captivity at CMFRI, Vizhinjam were monitored for infections along with the ambient hydrological conditions. The microbial load varied from 5.2 $X10^4$ to 9.52 $X10^5$ CFU ml^{-1}.

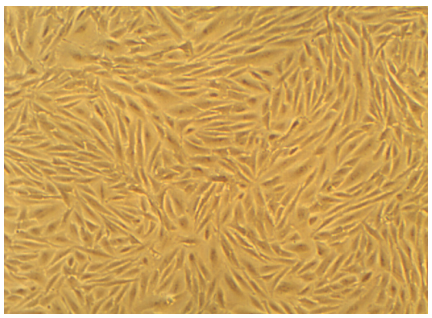
Tail erosion and blackening of joints and joint softness in *Panulirus homarus*

Marine fish cell lines

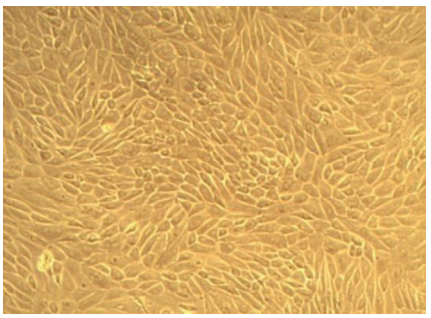
A total of 29 continuous cell lines have been established and characterised, from 4 species of marine food fish (*Cobia Rachycentron canadum*; Malabar grouper *Epinephelus malabaricus*; honey comb grouper *Epinephelus merra*; pompano *Trachinotus blochi* and the rabbit fish *Siganus canaliculatus*) and from 3 species of marine ornamental fish (three spot damsel *Dascyllus trimaculatus*; Caerulean damsel *Pomacentrus caeruleus* and the clown fish *Amphiprion sebae*). All the cell lines have been characterised by karyotyping and successfully cryopreserved in liquid nitrogen with good survival rate on revival.



Gill cell line from *E. malabaricus* (EM3GEx)



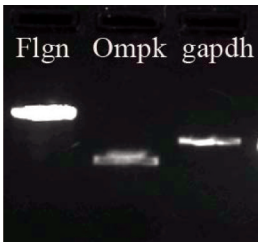
Heart cell line from cobia (RC4H1Tr)



Gill cell line from clown fish (AP1G1Ex)

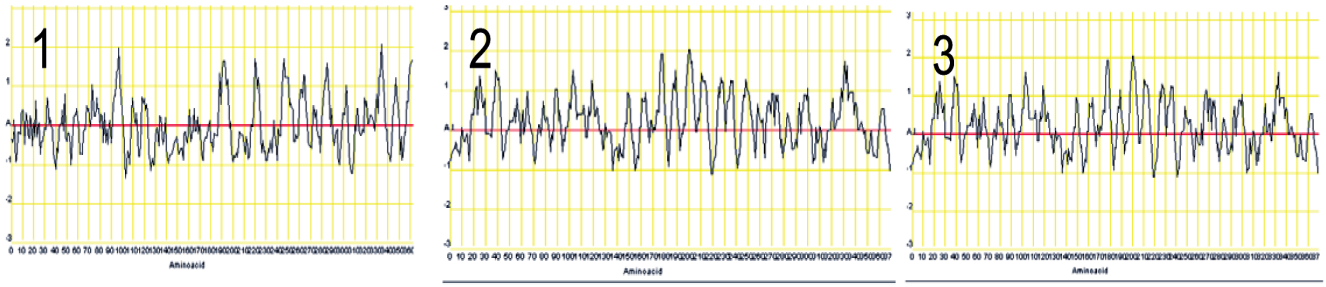
Recombinant antigen/DNA vaccine against major pathogenic vibrios

Genes coding for Glycerol-3-phosphate dehydrogenase (GAPDH), Outer membrane protein K (OmpK) and Flagellin were cloned, sequenced and characterised from pathogenic strains of *Vibrio alginolyticus*, *Vibrio anguillarum* and *Vibrio harveyi* isolated from moribund fishes. After in-silico translation, the sequences were analysed using bioinformatics tool for its



PCR amplification of Flagellin, OmpK and GAPDH from pathogenic Vibrios

ability to elicit an immune response. All the three proteins showed a higher antigenic index indicating that they were potential antigens, capable of eliciting a strong immune response. These proteins therefore can be a potent candidate for Recombinant/DNA vaccine.



Antigenic Index of 1.GAPDH; 2. Flagellin and 3. OmpK of *Vibrio alginolyticus*

Bioprospecting

Isolation and characterisation of antioxidant compounds from sea weeds from Gulf of Mannar

Methanolic extract and different solvent fractions obtained from seaweeds *Acanthophora spicifera* (Rhodophyta) and *Padina gymnospora* (Pheophyta) from Gulf of Mannar were evaluated for antioxidant activities and total phenolic contents. A higher level of phenolic content was observed with the fractions of *A. spicifera* especially for ethyl acetate fraction (119.28 GE g^{-1}) than that of *P. gymnospora.* Ethyl acetate extract of *A. spicifera* registered significantly higher ($p < 0.05$) activities with respect to ABTS.+ radical scavenging (37.8%), Fe2+ chelating (61.58%), and reducing abilities (Ab700nm 1.46) than *P. gymnospora.* The ability of ethyl acetate fraction of *A. spicifera* to inhibit the formation of TBARS and to scavenge. OH radical were significantly higher (4.21 MDEC kg^{-1} and 66.6%, respectively) than that of *P. gymnospora.* Bioassay guided purification of the fractions from *A. spicifera* led to the isolation of propyl 4-acetyl-2-(dimethyl-2-hexenyl) benzoate that was found to be highly effective (51.35%, IC50 0.55 mg ml^{-1}) followed by 3-acetyl-dihydroxy-dioxohexahydrobenzofuranyl hydroxy-3-oxobutanoate (32.20%, IC50 0.66 mg ml^{-1}) towards DPPH radical scavenging activity. Dichloromethane fraction of *P. gymnospora* yielded methylallyl oxoocta-dienoate (IC50 0.37 mg ml^{-1}), and was found to be effective to scavenge DPPH free radical. The present study provides valuable information regarding the potential of these seaweeds especially *A. spicifera* to develop natural sources for antioxidants as food supplements, for increasing the shelf-life in food industry, as nutraceuticals and/or functional foods, and candidates in combating carcinogenesis and inflammatory diseases.

Padina gymnospora

Green Algal extract (GAe) Cadalmin™ from seaweeds

The seaweeds belonging to different species were studied and the active biomolecules from these seaweeds were carefully processed, purified, and enriched to obtain a functional nutraceutical (the Green Algal Extract, GAe) which contains useful immunostimulating and anti-inflammatory ingredients. The active ingredients in GAe also suppress the build-up of uric acid in hyperuricemic patients. The GAe is a natural and 100% vegetarian product. With its therapeutic values, the green nutraceutical GAe is an import substitute with an international appeal, providing great market potential especially for the large vegetarian population in India and abroad.

Detailed evaluation using laboratory animal models proved that GAe could be safely taken without any side effects, providing relief to people suffering from arthritis and joint pain. GAe is chemically engineered to exhibit potentially high radical scavenging activity (98.46 – 99.32%). GAe also effectively prevents lipid peroxidation (4.61 mM MDA equivalent compounds per kg sample). These active principles competitively inhibit pro-inflammatory cyclooxygenase-II and lipooxygenase enzymes, resulting in decreased production of inflammatory prostaglandins and leukotrienes, and its activity was found to be superior to the synthetic non-steroidal anti-inflammatory drugs available in the market. The efficiency of GAe to inhibit these inflammatory enzymes stands at 64-94% as compared to 40-52% for the popular painkiller, aspirin. Time dependent *in vivo* animal model studies on experimental subjects revealed the superior inhibition of inflammatory response to the tune of 73-76% by GAe and its active components as compared to a maximum of 70% for the popular painkiller aspirin. GAe suppresses the edema produced by histamine, and exhibits its antiinflammatory action by means of either inhibiting the synthesis, release or action of anti-inflammatory mediators.

GAe is designed to find a unique way to prevent the degradation by air, moisture, heat, light, and to maximise the activity and shelf life. The product is free from carcinogenic trans fatty acids, radical adducts, low molecular weight carbonyl compounds, and inhibit the pathogenic bacterial build-up due to in-built antibacterial principles embedded in the product

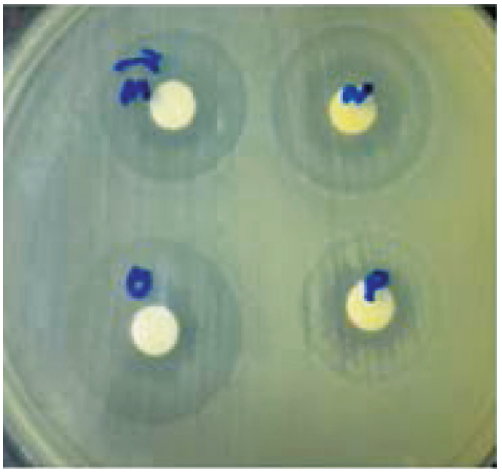
Acute toxicity studies of Cadalmin™ Green Mussel extract (GMe)

The acute toxicity studies and lethal dose of Cadalmin™ Green Mussel extract (GMe) using Wistar rats (20 males and 20 females) was carried out to understand its effect on various parameters like mortality, weight change, food consumption, haematological function, liver function, renal function, serum electrolytes and lipid profile. All the organs were examined visibly for any type of abnormalities in the structure, and the results indicated that GMe (2.5, 1.0 and 0.50 g kg^{-1} body weight) given to experimental subjects (male and female) for 14 days did not produce any change in food consumption, water consumption and body weights in rats, indicating that it has no toxicity to these animals. Also it did not produce any biochemical changes related to hepatic and renal function. GMe did not produce any change in haematological parameters such as WBC, RBC, platelet, haemoglobin and differential count. Necropsy of the treated animals showed normal appearance of various tissues. These results indicate that GMe do not produce any toxicity to the experimental subjects at the concentration (up to 4.0 g kg^{-1}) and duration studied (14 days), revealing the safety of the nutraceutical.

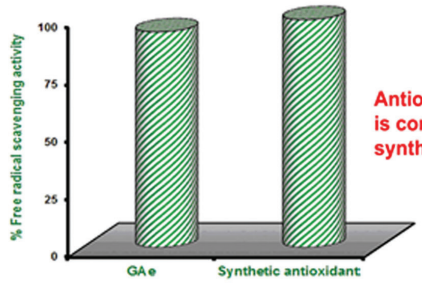
Characterisation of seaweed asscociated *Bacillus* spp. with respect to their antagonistic activity against mariculture pathogens and bioactive secondary metabolites from Penninsular India

From a total of 34 seaweed samples, 108 bacterial strains were isolated. All these strains were tested for antibiotic production against pathogenic *Vibrio* and *Aeromonas* species with 53 of them (49.7%) showing antibacterial activity. Thirteen percentage of the strains belonged to *Bacillus* species. The isolates were further characterised by PCR amplification using universal primer and the sequences have been deposited in NCBI with accession numbers JF834071- JF834078

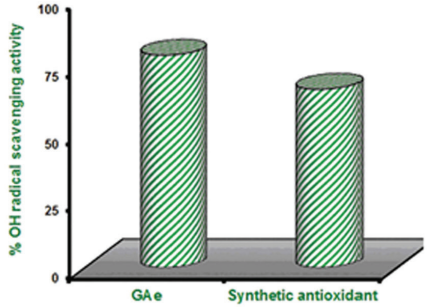
Bacillus subtilis (Accn. No. JF834074) has been bioprospected to isolate the bioactive principles by chromatographic procedures to yield about 23



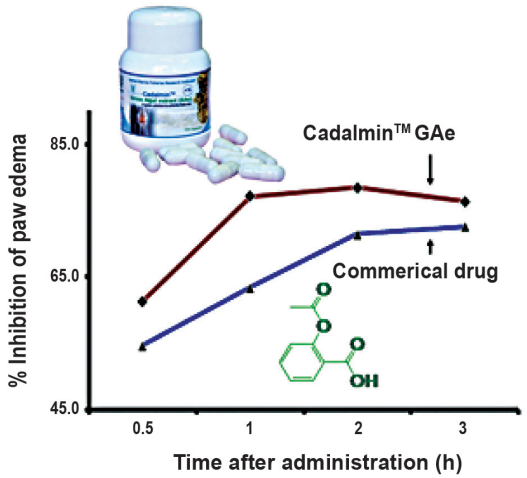
Antagonistic activity in *Bacillus* spp.



Antioxidant activity of cadalmin™ GAe is comparable to commercially used synthetic antioxidant



In-built antioxidant molecules in Cadalmin™ GAe confer high scavenging activity against deleterious free radicals resulting in assured shelf life



Carrangeenan-induced-paw edema and inhibition of inflammation by Cadalmin™ GAe

purified compounds. These were assayed for antibacterial activity against various aquaculture pathogens. The structure of the purified compounds were elucidated by spectroscopic techniques.

Isolation of microorganisms associated with sponges

The sponge, *Mycale mytilorum* collected off Vizhinjam coast was used for the isolation of sponge associated bacteria. The tissues were homogenised and plated onto Zobell marine agar as well as nutrient agar plates supplemented with sodium chloride. Phenotypically different colonies were isolated. Bioactivity studies revealed that two strains viz., *Bacillus subtilis* and *Bacillus boroniphilus* (Gen Bank Acc No: JQ409557 for *B. subtilis* and JQ409558 for *B. boroniphilus*) and their exo-cellular products exhibited antimicrobial as well as protease activities (Molecular weights: 20 and 58 kb for *B. subtilis* and 60 kb for *B. boroniphilus*). High antagonistic activity towards pathogenic *Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Enterobactor faecalis* was also recorded. Moderate antifungal activity was noted against the plant fungal pathogen, *Fusarium oxysporum.* Plasmids were isolated from bacterial strains suggesting a plasmid-mediated ECP production of the isolates. A total of three gene sequences obtained from sponge associated bacteria were deposited in GenBank.

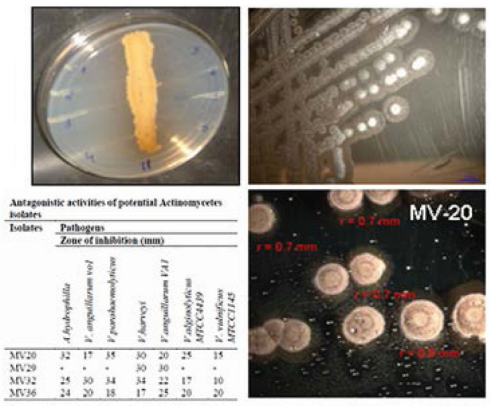
Details of gene sequence submissions of *Bacillus* spp. isolated from seaweeds

Gen Bank Acc. No.	Bacterial species
JF834071	*Bacillus amyloliquefaciens*
JF834072	*Bacillus amyloliquefaciens*
JF834073	*Bacillus subtilis*
JF834074	*Bacillus subtilis*
JF834075	*Bacillus* sp. PW19
JF834076	*Bacillus* sp. PW16b
JF834077	*Bacillus* sp.
JF834078	*Bacillus cereus*

Screening of bacteria with potential antagonistic activities against aquaculture pathogens from marine and mangrove ecosystem of the southwest coast of India

Actinobacteria

Colonies of actinomycetes were purified by repeated streaking on specific agar medium. The population density of actinobacteria varied with sample treatment and different culture media used for isolation. Colony size of the isolates varied from small to medium, powdery, and color varied from chalky white, grey and pink. Among several actinobacterial strains screened for antagonistic properties, MV20, 29, 30, and 36 isolated from mangrove sediment were found to be promising source of antibacterial metabolites.

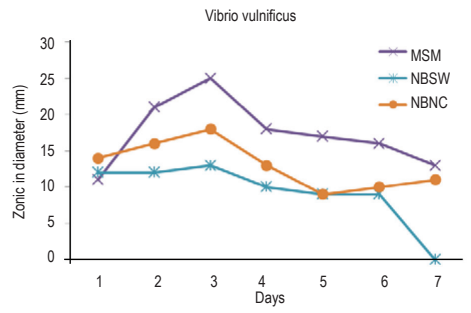


Saccharopolyspora spp. from mangrove sediments and their antibacterial activity

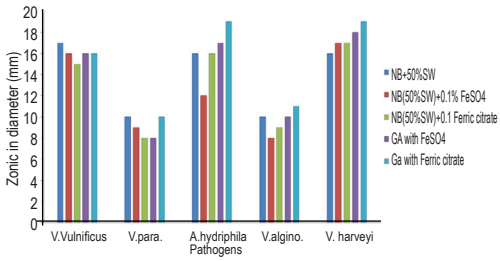
Thirteen out of the forty isolates were found to be potentially active against aquaculture pathogens with inhibition zone ranging from 15-30 mm. These isolates exhibited broad spectrum activity, and were therefore, selected for further characterisation. The actinobacteria were identified by morphological and biochemical characterisation as *Saccharopolyspora* spp. and the results were validated with PCR analyses with specific primers. Further purification of active principles from these candidate actinobacterial species are being carried out to identify the bioactive compounds for use against pathogenic *Vibrio* and *Aeromonas* spp.

Bacillus spp. and *Pseudomonas* spp.

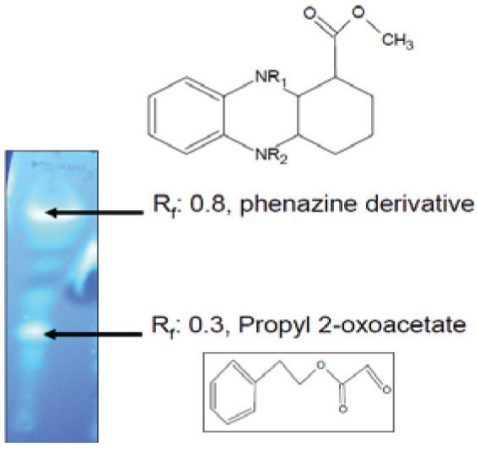
A total of 4960 isolates were screened for antagonistic potential, of which 51 isolates (1%) are effective in inhibiting majority of the important fish pathogens tested, belonging to genus *Vibrio* and *Aeromonas*. In the bath and intra-peritoneal challenge experiments against the juveniles of *Eteroplus maculatus,* except the fishes from control, all fishes in the challenged groups died in 5 days and confirmed the virulence of test pathogens. Identification of the potential isolates using biochemical method and 16S rRNA sequencing indicates that majority of the antagonistic strains belonged to Bacillus sp. (81%), followed by *Pseudomonas* sp. (19%).



Optimization of media using *Bacillus* subtilis BM2, titrated against *V. vulnificus* MTCC1145



Antagonistic activity of *Pseudomonas aeruginosa* P104 in various media



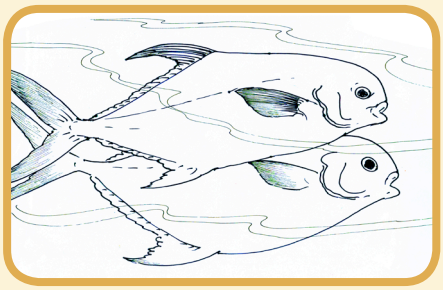
Thin layer chromatography showing the active fractions of P103

From the pool, 34 antagonistic isolates were assayed for beneficial aspects such as exoenzymatic activities, stress tolerance assay and antibiotic susceptibility pattern in order to use in aquaculture systems in product form and it was noticed that the genus *Pseudomonas* has the capacity to produce lipase, urease and gelatinase, while *Bacillus* sp. showed wide ranges of enzymatic activity differing between strains. Optimum physicochemical conditions were recorded as 15 ppt salinity, 30 °C temperature and pH 7 for all isolates.

Two media (Glycerol-alanine medium and Synthetic medium) have been standardised for *Pseudomonas* and *Bacillus* spp. which helps in the increased production of bioactive compounds and biomass. *Bacillus* was standardised using three different media like nutrient broth with 50% seawater (NBSW), nutrient broth with 1% NaCl (NBNC) and synthetic medium (MSM). *Pseudomonas* sp. has been standardised using NBSW, glycerol alanine (GA) medium, NBSW with $FeSO_4$ and ferric citrate and GA medium with $FeSO_4$ and ferric citrate.

Bioactive compounds responsible for antagonistic property in *Pseudomonas aeruginosa* P103

The bioactive compounds obtained after bioassay guided purification from *Pseudomonas* sp. on spectroscopic analysis were found to be chromophore of phenazine substitution and the auxochrome belong to the carboxyl ester moiety which is N-substituted methyl octahydro-1-phenazinecarboxylate and propyl 2-oxoacetate.



Broodstock Development

Food fishes

Cobia *(Rachycentron canadum)*

Wild collected cobia brooders (16 nos.) ranging from 9.0 to 33.0 kg weight are being maintained in two sea cages in the Gulf of Mannar. From captive bred F_1 generation, 58 fishes (8-17 kg size) were sexed, PIT tagged and are being reared in three sea cages for broodstock development. The stocking density of breeders in the sea cages is maintained at 1.5 kg per m^3. The broodstock fishes were fed with a diet of fresh sardines (70%) and portunid crabs/ squid (30%) at a rate of 5 % of their body weight per day. Vitamins (Vitamin A & E), PUFA (Fish oil, Squid oil, Krill oil, Cod liver oil, *etc.*) and mineral mixtures were also supplemented along with the regular diet. All the F_1 generation fishes were periodically assessed for their gonadal maturity and were used for breeding to pair with wild collected brooders.

F_1 Generation cobia fishes in sea cage

Cobia broodstock

Induction of spawning

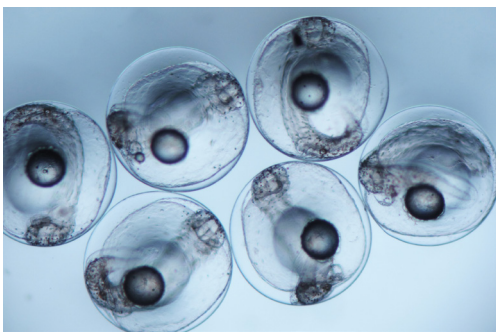
A total of 13 induction experiments were conducted after periodical assessment of reproductive stages of breeders maintained in the cages. Females with oocyte diameter of 700 µ and above were selected for induction experiments. Intra-muscular injection of Human Chorionic Gonadotropin (hCG) was administered @ 500 IU per kg body weight for females and 250 IU per kg body weight for males.

Date of Induction	Weight of brooders (kg)		Sex ratio (M:F)	Result
	Males	Female		
29.06.2011	14.0 & 14.5	35.0	2:1	No spawning occurred up to 72 hours
30.06.2011	10.0 & 9.0	15.5	2:1	No spawning occurred up to 72 hours
26.07.2011	15.0 & 13.5	18.0	2:1	Spawning occurred after 42 hours of hormone administration, but the eggs were very few and unfertilized
06.09.2011	16.0 & 17.0	31.0	2:1	Spawning occurred after 40 hours of hormone administration and the eggs were fertilized. The total quantity of eggs estimated was 0.5 million
05.10.2011	33.0 & 20.0	17.0	2:1	Spawning occurred after 39 hours of hormone administration and the eggs were fertilized. The total quantity of eggs estimated was 0.6 million

31.10. 2011	23.0 & 26.0	17.0	2:1	Spawning occurred after 42 hours of hormone administration and the eggs were fertilized. The total quantity of eggs estimated was 2.1 million
30.11.2011	23.5 & 26.0	17.5	2:1	Spawning occurred after 39 hours of hormone administration and the eggs were fertilized. The total quantity of eggs estimated was 2.8 million
03.12.2011	21.0 & 26.5	32.5	2:1	Female fish collapsed during the experiment
27.12.2011	22.0 & 18.0	30.0	2:1	Spawning occurred after 48 hours of hormone administration, but the eggs were unfertilized and estimated to be 1.0 million
18.01.2012	33.0 & 17.0	17.0	2:1	Spawning occurred after 38 hours of hormone administration and the eggs were unfertilized. The estimated number was about 0.6 million but the embryonic development was arrested after 6-8 hours of fertilization.
31.01.2012	33.0 & 17.0	17.0	2:1	No spawning occurred up to 72 hours
18.02.2012	33.0 & 17.0	29.5	2:1	Spawning occurred after 48 hours of hormone administration, but the eggs were unfertilized and estimated to be 1.0 million
14.03.2012	17.0 & 18.0	30.0	2: 1	Spawning occurred after 48 hours of hormone administration and the fertilised eggs were estimated to be 0.3million.

Pompano Spawner

Cannulation of Pompano breeder fish



Fertilized eggs of Pompano

Pompano *(Trachinotus blochii)*

The silver pompano, *Trachinotus blochii* is one of the suitable species for aquaculture, mainly due to its fast growth rate, good meat quality and high market demand. At Mandapam Regional Centre of CMFRI, successful broodstock development, induction of spawning and fingerling production of silver pompano was achieved for the first time in India.

Wild collected pompano ranging in size from 250 to 500 g were stocked in sea cages of 6 meter diameter and 3.5 meter depth and fed *ad libitum* once in a day with trash fish. A total of 4 nos. of cage reared adult pompano (1 female and 3 males) were selected and transferred to an indoor FRP tank of 10 m^3 capacity with photoperiod control facility (15 L: 9 D) for pre-conditioning the fishes to induce spawning.

The breeders were fed *ad libitum* with squid meat and fish roe once a day and water quality was maintained by a flow-through system. The female having intra-ovarian eggs of diameter above 500 µ was used for induction of spawning. The maturity of the males was assessed based on milt quality. The breeders were administered with hCG at a dosage of 350 IU per kg body weight and spawned approximately 38 hours after induction.

Experiments on spawning induction

A total of 5 induction experiments were conducted after periodical assessment of reproductive stages of brood fishes maintained in the photoperiod controlled tanks.

Date of spawning	Hormone	No. of spawned eggs	Temperature
07.07.2011	hCG	137920	28 to 29
08.08.2011	hCG	60000	27 to 28.9
12.09.2011	hCG	75000	27 to 28.5
21.10.2011	hCG	175000	27 to 28
17.11.2011	hCG	125000	26.5 to 27.5

Pearlspot *(Etroplus suratensis)*

Broodstock development of pearl spot was carried out in earthen ponds at KVK Narakkal with 1500 adult fishes (100-200 g). Fishes were fed twice a day *ad libitum* with artificial diets. Suitable substrates were provided along the sides of the ponds for egg laying and attached eggs were carefully removed along with substratum from the pond and brought to hatchery for hatching and further rearing. In a single spawning, 900 - 1500 eggs were laid on the substratum.

Pearlspot eggs

Groupers (*Epinephelus tauvina* and *Cromileptes altivelis)*

At Visakhapatnam, broodstock of the grouper (52 nos.), *Epinephelus tauvina* (2- 9.5 kg), were PIT tagged and maintained in a cage and fed with squid and trash fishes fortified with vitamins @ 5 % body weight. From that, 20 fishes were stocked in another cage for sex reversal trial. Among them, 11 fishes of different size (3-9 kg) were implanted with 17- alpha Methyl Testosterone @ of 5 mg per kg body weight; 5 fishes with 5mg/kg body weight MT and 0.2mg/kg body weight letrazole and remaining 4 fishes implanted with 5mg/kg body weight MT and 0.4mg/kg letrazole for the sex reversal experiment. Gonadal maturity stages were being examined in every month by stripping and cannulation.

Broodstock of *Cromileptes altivelis*

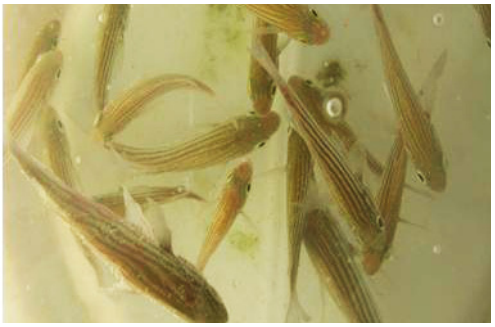
Oral administration of the male hormone 17 alpha Methyl Testosterone (1 mg/ kg body weight) along with letrazole (0.05 mg/kg body weight) on daily basis was carried out to five medium size fishes maintained in the hatchery for sex reversal studies. The testosterone and letrazole were weighed and filled in empty capsules. These capsules were fed to the groupers along with their diet. The hormone treated fish were examined once in a month by cannulation and stripping. For sex reversal, pellet implantation trials yielded successful results than the oral administration of hormones through feed. Three spawning trials were carried out using hCG at different dosages. In all the cases spawning yielded only unfertilized eggs.

Broodstock of Malabar red snapper

Barramundi cod *Cromileptes altivelis* is being reared in 10 ton indoor recirculating tank for developing broodstock at Vizhinjam Research Centre.

Snappers (*Lutjanus argentimaculatus, L. johni & L. russelli)*

The broodstock development of Malabar red snapper, *Lutjanus argentimaculatus,* is being continued at Karwar, Calicut and Kochi. Fishes with a weight of more than 1 kg and also those with matured gonads were tagged using PIT tags and maintained in separate cages. Maximum weight attained by *L. argentimaculatus* was 1.45 kg and that of *L. johni* was 1.8 kg whereas *L. russelli* attained a maximum weight of 790 g after nine months of stocking.



Broodstock of goldlined seabream

Seabream (*Rhabdosargus sarba*)

Small and medium sized fishes (50 nos.) of Goldlined seabream *Rhabdosargus sarba*, collected from hooks and line were maintained in cages (4x4 m) at Vizhinjam for broodstock development.

Marine ornamental fishes

Broodstock development and successful breeding of four species of clown fish *viz. Amphiprion ephippium, A. frenatus, A. clarkii and A. peridarion* was achieved.

Broodstock development of five species of ornamental fishes *viz. Nemeteleotris magnifica, N. decora, Ptereleotris evides, Pholidichthys leucotaenia* and *Pterapogon kauderni* are progressing at Kochi.

Brooder of fire clown

Brooders of Pink skunk clownfish

A pair of purple firefish *N. decora*

Broodstocks of Scissortail dartfish *Pterelеotris evides*

Shellfishes

Lobsters

Captive breeding of spiny and sand lobsters is being continuously carried out at Chennai Research Centre, using only natural stimulus for the spawning. So far the broodstock development trials have delivered 20 breeding pairs (11 sand lobsters and 9 spiny lobsters). Broodstock development of sand lobsters were also initiated at Tuticorin.

Mussels

Experiments on the maturation of mussels in temperature controlled environment by feeding them with plankton mainly with *Isochrysis galbana* culture is being carried out at Calicut.

Pearl oysters

Pinctada margaritifera spat were collected from Lawson's Bay at Visakhapatnam and they were maintained on *Isochrysis galbana, Nannochloropsis* sp. and *Cheatoceros calcitrans*. The broodstock was successfully developed with a strict feeding regime and 7 successful spawnings were achieved.

Pinctada fucata maintained in the farm were brought to the conditioning room and maintained under mixed algal feeding, predominantly of *Chaetoceros* spp. The pearl oysters gradually matured and fully ripe oysters were used for spawning experiments. Most of them spawned naturally and thermal induction was attempted when spontaneous spawning was not occurred. A total of two spawning experiments were conducted and 25,000 spats (Av. 5mm) of *Pinctada fucata* were produced and used for different studies.

Edible clams (*Paphia malabarica* and *Meretrix meretrix*)

Wild breeders of edible clams were collected from the Karapad bay, maintained for conditioning and thermally induced to spawn. Both *Paphia malabarica* and *Meretrix meretrix* responded and spawned. The larvae were successfully reared through settlement following conventional method.

Seed Production

Cobia *(Rachycentron canadum)*

Larviculture protocols for Cobia *(Rachycentron canadum)* were refined by appropriate management of live feeds, taking into consideration the nutrient requirements of the larvae and density of feed in the larval tanks. The larvae were stocked in FRP tanks of 5 ton capacity and cement tanks of 60 ton capacity for larviculture. The intensive larviculture tanks were provided with green water at a density of about 1x 10^5 cells/ml and rotifers enriched with the commercial enrichment medium 'Sparkle (INVE)' at a density of 6-8 nos. /ml from 3 to 9 dph. The critical stage for the larvae was 5 to 7 dph when they entirely resorted to exogenous feeding.

From 9 to 21 dph, the larvae were fed four times daily with enriched *Artemia* nauplii maintained at a density of 2-3 nos. of nauplii per/ml in larviculture tanks. During this period, co-feeding with rotifers was also continued as to feed different size groups of larvae. From 18 dph onwards, weaning the larvae to larval inert feeds was started.

From 25 dph, grading of larvae was started. The shooters were fed exclusively with the artificial feed of the size 500-800µ and 800-1200 µ.

Two-stage nursery rearing of fingerlings was done for cobia. The first phase was carried out in indoor 5 tonne capacity FRP tanks. About 250 numbers of fingerlings were reared in each 5 tonne tank with 100% water exchange, twice a day. They were fed both by formulated feeds as well as with chopped sardines. Indoor nursery rearing was continued for 30 days and when the fingerlings attained a length range of 14-19 cm and weight range of 22-51 g, they were transferred to nursery cages.

The second phase of nursery rearing in cages was done for about 20 days. During the period, they were fed with chopped trash fish. At the

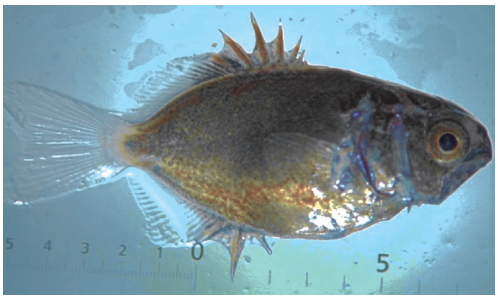
25 dph Cobia larvae

Days post-hatch	Size of larve	Size of feed
18-19 dph	2.3 to 2.6 cm	100-200 µ
20-23 dph	2.5 to 3.5 cm	300-500 µ
23-30 dph	3.5 to 8 cm	500-800 µ
31 dph onwards		800-1200 µ

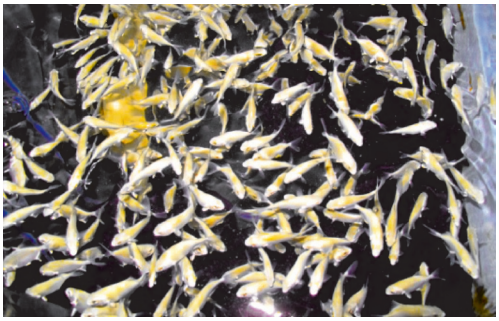
Details of Cobia larval production at Mandapam

Batch No.	Date of spawning	No. of spawned eggs (million)	Percentage of fertilization (%)	Percentage of hatching (%)
1.	08.09.2011	0.5	28.0	80.0
2.	07.10.2011	0.6	70.0	80.0
3.	02.11.2011	2.1	60.0	75.0
4.	02.12.2011	2.8	80.0	75.0
5.	29.12.2011	1.0	0.0	Nil
6.	20.01.2012	0.6	60.0	0.0
7.	20.02.2012	1.0	0.0	Nil

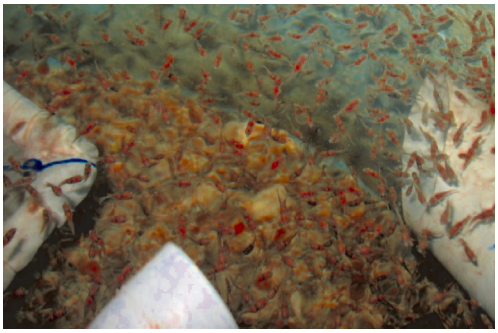
Cobia fingerlings (55 dph)



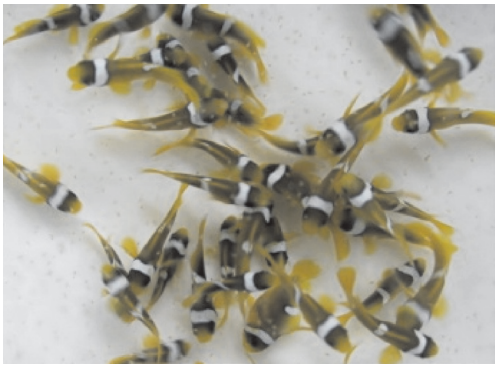
17 dhp pompano larva



45 dph pompano fingerlings



Pearlspot fingerlings



Juveniles of *Amphiprion ephippium*

end of this nursery phase, the length range of fingerlings was 18-21 cm and weight range 28-67 g.

The live feeds required for larviculture *viz*., *Nannochloropsis*, rotifers and nauplii of *Artemia* were mass-produced and enrichment procedures were standardised. In addition, the commercially available algal paste (Nano-3600) was also used to meet the requirement of green water for larviculture.

Pompano (*Trachinotus blochii*)

Larviculture protocols were standardized by using appropriate live feeds in required quantities by taking into consideration, the nutritional requirements of the newly hatched larvae. Larvae were stocked in FRP tanks of 2 ton capacity with 1.5 tons of green water *(Nannochloropsis*) for larviculture. The intensive larviculture tanks were provided with green water at a density of about 1 x 10^5 cells/ml and rotifers enriched with 'Sparkle (INVE)' at a density of 5-6 nos. /ml from 3 to 10 dph. The critical stage for the larvae was 3 to 7dph when they entirely resort to exogenous feeding from yolk sac nutrition. From 8 to19 dph, the larvae were fed four times daily with enriched *Artemia* nauplii by maintaining 1-2 nos of nauplii/ml. During this period, co-feeding with rotifers was also continued for the different size groups of larvae available in the tank.

Weaning to larval inert diets was started from 15 dph onwards. Size of weaning feeds used was 100-200 µ for 13-18 dph, 300-500 µ for 18-20 dph, 500-800 µ for 20-30 dph larvae and 800-1200 µ for 31 dph onwards.

Larval metamorphosis was noticed from 18 dph onwards (black to silvery colour). The metamorphosis of all the larvae was completed by 25 dph. From 25 dph, grading of larvae was started. The shooters were fed exclusively with the artificial feed of 800-1200 µ size. After attaining 35 dph, the fingerlings were fed with artificial feed of 1500 µ size.

Nursery rearing of fingerlings was continued in 5 tonne tanks up to 55 dph and thereafter they were transferred to 5 x 5 m square cage with mesh size of 20 mm. The stocking density was maintained at 35 nos./m^3. Initially, fingerlings were fed *adlibitum* twice a day with 1.8 mm extruded floating pellet feed containing 40% crude protein and 8% crude fat.

Pearlspot (*Etroplus suratensis*)

The eggs brought from broodstock ponds were hatched in indoor tanks by providing artificial circulation using an underwater pump. Hatching of 70-90% was observed in hatchery. The hatched out larvae started exogenous feeding after 3-4 days of hatching. Pearlspot larvae were fed with freshly hatched *Artemia* and copepods collected from wild for the initial 7 days. Thereafter artificial encapsulated prawn larval feeds (size >150µ microns) were given. After 20 days of rearing *Artemia* feeding was stopped and larvae were fed solely with artificial diets. These feeds were fortified with HUFA rich fish oils and dried algal powder. After 45-60 days the larvae became juveniles and measured 2.5 to 3 cm. An average survival of 70% from eggs to juveniles was obtained in each trial.

Since September 2011, a total of 12, 000 nos. of hatchery produced *Etroplus* seeds (size: 5 cm to 12 cm) were supplied to different farmers

Ornamental fishes

Seed production of four species of clown fish *viz*., *Amphiprion ephippium, A. frenatus, A. clarkii* and *A. peridarion* was achieved in hatchery.

The hatchery produced seeds of marine ornamental fishes (*Amphiprion ocellaris, Amphiprion percula, Amphiprion sebae, Amphiprion nigripus, Premnas biaculeatus, Pomacentrus caeruleus, Amphiprion frenatus, Amphiprion peridarion. Chrysiptera cyanea* and *Dascyllus aruanus* and 12 species of Microalgae stock culture) were sold to aquarists and aquarium traders. The total amount generated from the sales of hatchery produced seeds of the above species was Rs. 4,35,175/- during the period of 2011-2012.The amount was remitted under the account head of the ICAR Mega seed project.

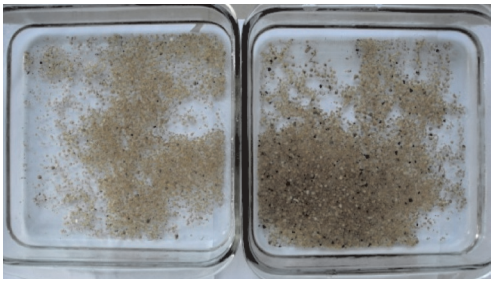
Modified LRT for mass rearing

Sand lobster

Innovations on system designs, environmental manipulations, larval feeding strategies and microbial interventions were experimented for enhancing the survival rates of sand lobster larvae.

Pearl oyster (*Pinctada fucata*)

Two spawning experiments were conducted and a total of 25,000 spats (Av. 5 mm) of *Pinctada fucata* were produced and used for other studies.



Meretrix meretrix seed (85 day old)

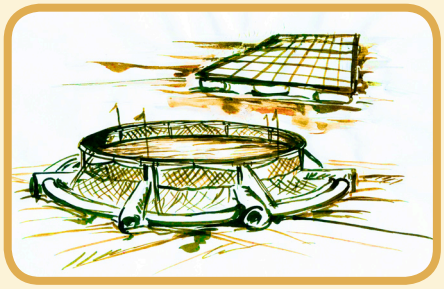
Edible clams (*Paphia malabarica* and *Meretrix meretrix*)

A total of 10,000 seeds of *Paphia malabarica* and 70,000 seeds of *Meretrix meretrix* were produced at Tuticorin. *Meretrix meretrix* seeds are being nursery reared for farming experiments.

Edible oyster

At the oyster hatchery developed at Narakkal. 15,060 numbers of cultchless spat were produced through settlement of spat on the polyethylene sheet and clam shell grits provided in the tanks. Spats settled on the polyethylene sheet and clam shell grits provided in the tanks grew uniform shape. These uniform shaped spats or juveniles were farmed to get larger ones of uniform shape which fetched good price to the farmer. This uniform shape oyster had very good demand for live consumption in high-end restaurants.

Oyster Spat settled on the polyethylene sheet



Growout Culture

Cobia juveniles (75 dph) in sea cage at Mandapam

Demonstration pond at Anthervedi, Andhra Pradesh

Sampling of cobia at Anthervedi farm

Cobia juvenile from Anthervedi farm

Cobia *(Rachycentron canadum)*

The growout culture of cobia was done in 5 x 5 m HDPE square cage. The nursery reared cobia fingerlings were stocked at a stocking density of 6-7 nos. per m^3. The fishes were fed @ 5% of their body weight with 4.5 mm size extruded floating pellet feed containing 40% crude protein and 8% fat. The average length and weight of cobia stocked was 19.5 cm and 41.5 g, respectively. The grow-out culture of cobia is in progress.

Pond culture of cobia

A farming trial of cobia is being carried out in a brackish water aquaculture pond of a private entrepreneur at Anthervedi Village, East Godavari District, Andhra Pradesh. The fishes are being fed with 1.8 mm size extruded floating pellet feed @ 5% of their body weight containing 40% crude protein and 8% fat. Cobia seeds were stocked in the pond with average length and weight of 16.3 cm and 17.5 g respectively. After 90^{th} day of stocking the average length and weight were 28 cm and 120 g respectively.

Growout culture of pompano *(Trachinotus blochii)* in sea cages

A total of 3,000 numbers of pompano fingerlings with an average weight of 10 grams were stocked in two circular HDPE cage of 6 m diameter and 3 m depth. The stocking density was maintained at 15 per m^3. The fishes in grow-out cages were fed @ 5% of their body weight with 1.8 mm size extruded floating pellet feed containing 40% crude protein and 8% fat. After reaching 150 grams size the fishes were fed @ 3-4% of their body weight with 4.5 mm size extruded floating pellet feed containing 40% crude protein and 8% fat. The fishes reached an average weight of 250 g at the end of 180 days. The grow-out culture of pompano is in progress.

Pompano farming in low cost GI cage

Farming experiment of pompano is being carried out at Vedalai village, Ramanathapuram District, with the help of a fisherman. Initial nursery rearing of 1200 numbers of pompano with an average size of 2 grams was carried out in a 6 m^2 pen erected at a depth of 1.5 meters. After attaining an average size of 30 grams, fishes were stocked in a low cost 5 x 5 m GI square cage. The fishes are fed *ad libitum* with chopped trash fishes. The grow-out culture of pompano in the low cost cage is in progress.

Pompano farming demonstrations in brackishwater ponds

Farming trial of pompano in brackish water aquaculture pond is being carried out at Anthervedi Village, East Godavari District, Andhra Pradesh.

A total of 4,000 fingerlings of 4 cm average size were transported from the MRC of CMFRI Mandapam on 14th August 2011 and were stocked in a 1.0 hectare pond. The fishes were fed with 1.8 mm size extruded floating pellet feed @ 5% of their body weight containing 40 % crude protein and 8% fat. When the fishes attained an average weight of 150 grams, they were fed with 4.5 mm size extruded floating pellet feed @ 3 - 4% of their body weight containing 40% crude protein and 8% fat. The fishes have attained an average weight of 350 grams in about 210 days and the farming trial is being continued.

Stocking of pompano fingerlings in the cage

In another farming trial, 3,000 seeds were stocked in a 1.5 acre brackishwater pond (14 ppt) located at Akkivedu Village, West Godavari District, Andhra Pradesh. The fishes were fed *ad libitum* with sinking pellet feed consisting of 40% crude protein and 6% crude fat. After rearing for about 90 days, the fishes have reached an average size of 50 grams. The farming trial is being continued.

To assess the growth of pompano in tide fed aquaculture pond, 2,500 fishes were stocked in a 1.2 acre pond located near Sahupuram, Tuticorin District, Tamil Nadu. The salinity of sea water at the time of stocking was 22 ppt. The fishes were fed *ad libitum* with chopped trash fish. The fishes weighed 30 grams at the end of 70 days of culture. The farming trial is being continued.

Pompano after 210 days of growout culture

Nursery culture of *Mugil cephalus*

M. cephalus fry of size 1.5 to 2.0 cm (10,000 numbers), collected from Puthuveypu area, Vypeen Island were nursery reared in hapas. They were stocked in 2m x 2m x1.5 m velon hapas in a private earthen pond located 2 km away from the collection site. Each hapa was stocked with 2000 numbers. Feeding was done thrice a day with dry mix of wheat bran and wheat flour mixed at 1:1 ratio. After two months, about 7500 numbers were distributed in 2 m x 2 m x 1.5 m HDPE hapas with 10 mm mesh size at the rate of 1500 numbers per hapa. After 150 days, they reached a size of 10-15 cm with a survival 75%. After nursery rearing, the seeds were stocked in grow out cages for further rearing.

Inland saline water fed pond

Culture of *Mugil cephalus* in floating cages

A 6 m diameter HDPE cage was installed at Chittattukara Panchayat, Ernakulam district during January 2012. The volume of the net bag is calculated to be 127 m^3. The cage is moored at a depth of 5.5 m using anchors as well as bamboo poles. The salinity of the site is between 15-18 ppt. A total of 5500 numbers of juveniles measuring 10-15 cm size were stocked in the cage .Two hundred numbers of silver pompano brought from Mandapam RC of CMFRI and 150 numbers of pearlspot produced at CMFRI hatchery, Cochin are also stocked in the cage. Initial mesh size for grow-out net is 16 mm and net change was done after 30 days due to clogging with periphyton. Farming is progressing.

At Cherianthuruth, Cochin, a society comprised of 60 fishermen was involved in the cage culture activities. Circular 6m diameter HDPE cage was used for the farming of pearl spot and mullet. The site with brackishwater environment had a depth of >6m and adequate water flow. The operation and management of the cages was entrusted to farmer group by means of Farmer-Scientists interaction mode. The cage was stocked with 5000 numbers of fishes (pearl spot and mullets). The pearl spot juveniles of size ranging from 20-40 g were stocked in cages.

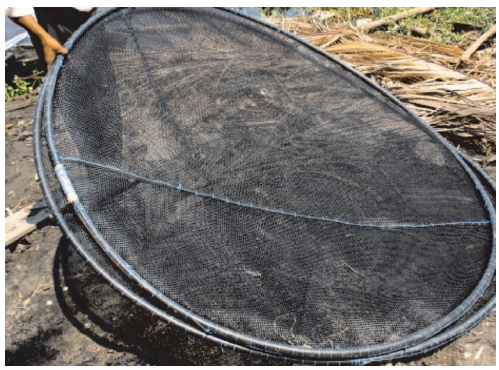
Cage installation at Chittattukara, Cochin

Cages being launched in Krishna River system, Nagaya Lanka

HDPE net cage of 18 mm mesh size was used. The cage was moored using anchors placed on both sides of the cage with additional anchoring using cement blocks as a precaution. Mullet (*Mugil cephalus*) seeds reared in hapa in ponds were transferred to the cage. Wet balls made of groundnut oil cake and rice bran were fed two times a day *ad libitum* to fishes using the feeding trays suspended inside the cages. Cooked rice and low protein pellet feeds were also given. The farmer group is doing partial harvest of pearl spot at 250 to 400 g size with periodic stocking with juvenile fishes.

Cage culture of pearlspot *Etroplus suratensis*

Two indigenously fabricated high-density polyethylene (HDPE) floating cage measuring 6 m diameter was used for cage culture in Krishna River system at Nagaya Lanka, Andhra Pradesh. The effective volume of the net bag used in the culture is about 127 m^3. The cage was moored using anchor at a depth of 7 m in Krishna River 1 km away from bar mouth, where the salinity of the site ranged from 20 to 23 ppt with approximately 1 m tidal amplitude. Pearlspot *Etroplus suratensis* fry (4-5 g) collected from the flood filled earthen ponds were directly stocked into the cages. About 15,000 numbers of Pearlspot juveniles were stocked in one cage. The other cage was stocked with 2000 numbers of 40-50 g size seabass *Lates calcarifer*. Wet feed dough balls using commercial low protein pellet feed was recommended for pearlspot feeding. While, seabass was given 35% protein pellet feed. Feeding trays were kept inside the cage and feed was placed in this.



Additional layers used inside shrimp cage

Cage culture of shrimp

A HDPE cage of 2 m diameter was modified for the culture of Indian white prawn, *Fenneropenaeus indicus*.. The inner net cage was made of 8 mm mesh nylon netting. For providing additional surface area, modifications were made with additional layers using netlon materials. A three fold increase in surface area was thus obtained. Three layers were thus provided and feeding to each layer was done through pipes.

Stocking of the cage was done @ 100 /m^2. Each layer was stocked with 300 numbers of *F. indicus* post-larvae. Feed was allowed to fall directly to the feeding trays fixed on each layer through pipes. Feeding was done thrice a day using pellet feeds. About 30% of the stock was retrieved on harvest. Further experimentation and modifications has to be done for better results in cage culture of shrimp.

Cage farming demonstration of Asian Seabass *Lates calcarifer* in cages

Cages at Antarvedi

At Antarvedi, two 6 m diameter HDPE cages installed in the Godavari River in East Godavari district of Andhra Pradesh was stocked with 8500 nos. of juvenile seabass weighing 50-70 g. The cages were anchored using coconut poles drilled 10 ft into the river bed and the bottom ballast was tied to the poles along with the nets to retain the volume of the net. The fish were fed *ad libitum* twice a day with chopped low cost fish procured from local fishing village for a period of six months. The crop was harvested after 6 months at a size ranging from 600 g to 1500 g and a production of three tonnes was obtained from each cage.

Production of black pearl

Pearl seeding on *Pinctada margaritifera* was undertaken by a Polynesian expert during January-February 2011. The seeded oysters were then hinge notch drilled and hung from chaplets in an undersea longline system in

Port Blair. Out of the 13 oysters which were implanted with both bio-coated nuclei and mantle pieces, 2 oysters survived and 2 pearls were recovered after a period of nearly one year. These are the first black pearls produced through farming in the country. The details of the pearls obtained are given in table. Black pearls produced had a unique golden hue which would fetch premium price in international markets.

Cultured black pearl

Cultured black pearls produced for the first time in India

Particulars	Cultured black pearl - 1	Cultured black pearl - 2
Length (mm)	4.81	3.84
Width (mm)	3.65	3.14
Weight (mg)	76.8 [0.38 carats]	54.0 [0.27 carats]
Shape	Oval – baroque	Oval – baroque
Colour	Grey-black/ golden hue	Grey-black/ golden hue
Approximate value	US$ 50	US$ 40
Days of culture	307	368
Oyster details		
DVM (mm)	87.15	91.73
Thickness (mm)	25.89	25.34
Weight (g)	108.2	130.5
Depth of farm		7m
Rearing in		Chaplets with wire mesh cover
Method of farming		Sub surface longline
Implantation technique		Tahitian – no narcotics
Insertion		Mantle piece
Percent recovery		15% (2/13)

Mabe pearls produced at Vizhinjam

Mabe pearl

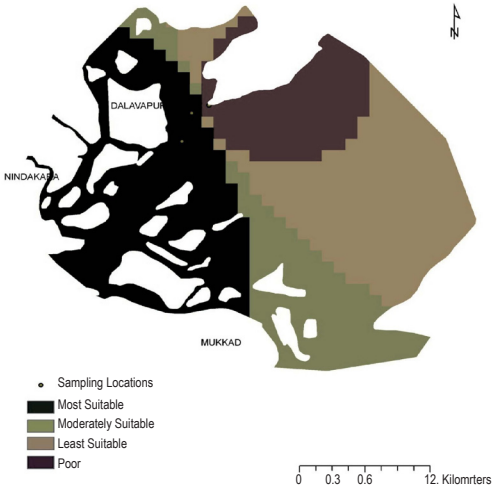
Techniques for production of image pearl nuclei using shell cement and acrylic polymer were developed. It consisted of an eight- step process involving making of metal templates, making of mould, hot and cold process of image nuclei making, grinding the nuclei to proper size. The methodology was standardized for making images using acrylic polymer (DPI RR cold cure polymer resin) and shell powder. Quality image pearl nuclei were produced using this method and used for implantation.

Black-lip pearl oyster resource enhancement programme [ANPOREP]

The ANPOREP concept which was launched to enhance the natural stock of black-lip pearl oysters in the Andaman and Nicobar Islands was continued this year with spat produced in the hatchery. In February 2012, at GSS school Rangachang, a group of 12 students participated as 2 teams headed by Masters Raja class 7th, and Anand, class 8th. The students packed the black-lip pearl oyster spat in specially designed net cages for transfer and husbandry in the inter-tidal and sub-tidal beds near the school in Rangachang village.

Students moving the spat filled cages to sub-tidal rock pools

New set of Pens – Karapad Bay, Tuticorin



GIS rendering of areas suitable for clam farming in Ashtamudi Lake, Kerala

Cold smoked oysters on shell – a new product developed

IQF oysters ready for sale

Pen culture of clam, *Paphia malabarica*

Successful pen culture of the clam *Paphia malabarica* was done at Tuticorin. Hatchery produced and nursery reared clam seeds of *Paphia malabarica* with average size of 3.4 mm were transplanted in the velon net made pen of 3x3 m size. Stocking density was maintained at 400 nos/sqm. After a culture period of 9 months, the clams had grown to a size range of 28.5 to 37.9 (35.8 mm) / 6.2 to 11.4 g (11.2 g) in the different pens. The average monthly growth in terms of length/weight was estimated to be 3.6 mm/1.2 g.

Standardization of farming protocols for short-neck clam *Paphia malabarica* and the black clam *Villorita cyprinoides*.

Experiments for developing clam farming protocols for the short-neck clam *Paphia malabarica* and the black clam *Villorita cyprinoides* were conducted and the complete protocols were standardized. On-bottom pen system was found to be the best for both species. Optimum stocking density was 550/m^2 for both species. Both species preferred ~70-80% sandy substratum. About 30% improvement in meat weight and counts could be obtained by scientific re-laying.

The areas suitable for clam farming in Ashatmudi and Vembanad Lakes were identified using a scoring pattern with hydrographic and sediment parameters and also taking into account anthropogenic activities in the vicinity. The areas were then rendered in a GIS format.

Development of a value chain on high value shellfishes from mariculture systems

At the oyster hatchery of one lakh seed per annum developed at Narakkal. Around15,060 numbers of cultchless spat were produced through settlement of spat on the polyethylene sheet and clam shell grits provided in the tanks. The farmed oysters were harvested from May 15th, 2011 onwards. The estimated farmed production was 3200 tonnes during this season, indicating an increase of 28% over that of 2010 (2500 tonnes) and 113% over that of 2009 (1500 tonnes).

Two ready to eat value added oyster products *viz*., smoked oyster in oil (in retortable pouch and TFS can) and smoked single oyster shell-on were developed and marketed under the brand name "MUZIRIS" through the NIFPHATT fish stall. Most preferred oyster product of the nine products developed under the NAIP project till now was identified as oyster curry in coconut milk and IQF oyster. Large scale production and market promotion of these products under the brand name "MUZIRIS" was carried out during this period. Two new value chains developed under the NAIP *viz*., fresh depurated oysters for live consumption in high-end restaurants and production and marketing of value-added-products of farmed oysters were intensified.

Techniques for broodstock maturation and breeding in captivity for the sand lobster were standardized. Mass larval rearing protocol upto final larval and settlement stage, with maximum survival rate of 20% upto final phyllosoma stage was also developed.

Evaluation of the health status of edible oysters from the different locations such as Tuticorin, Kollam and Cochin were made by assessing the general health condition through condition index values (CI) and recording the presence of parasite, intensity of infection, prevalence and extent of tissue pathology caused.

Farming of edible oyster

A total of 3200 tonnes of farmed oysters were harvested during this season from Cochin backwaters.

Marine Biodiversity

Hard corals

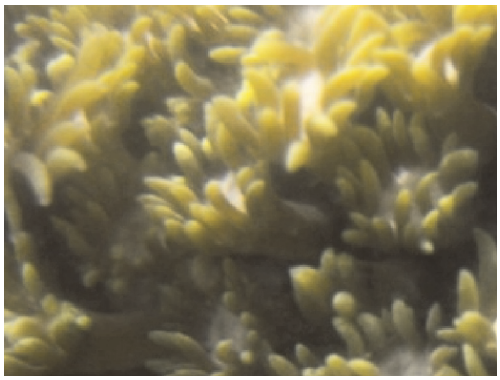
Underwater surveys were conducted during 2011-2012 period following Line Intercept Transect Method along Enayam to Kollam waters in South India to assess the coral reefs. The present status of patchy reefs revealed a decline in the existing coral cover due to encrustation by zooanthids and bleaching of corals in Enayam. The study also revealed reduction in coral growth in the Vizhinjam Bay due to sedimentation and other anthropogenic activities. But outside the Bay, live coral colonies on the rocks were found to be in healthy condition as several new recruits observed in this area. However, in Thankassery Harbour, coral colonies of *Pocillopora damicornis, P. verucosa, P. meandrina* and *Porits lutea* were recorded whereas in Thirumullavaram the entire coral cover was dominated by a single species belonging to the genus *Porites* which formed 82% of the total transect area.

Experiments for growth studies of hard corals were initiated in 2010-11 period with the view to replenish the degraded coral beds in Vizhinjam Bay using the available coral, *Pocillopora* sp. suspended from a floating raft with different substrates such as plastic baskets, cement coated bricks and acrylic sheets. Although all the fragments were found completely attached to the substrates, the rate of attachment was comparatively faster in the cement coated bricks than the acrylic sheets.

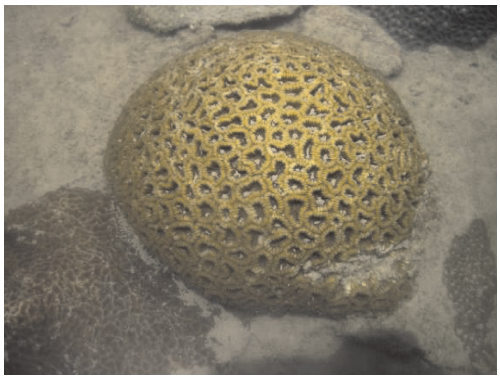
A unique bacterial strain C29 was isolated from *Porites* sp. collected from Vizhinjam Bay forming pink translucent bacterial colonies on Marine broth (MB) agar. These were the predominant colonies grown on direct plating of the coral tissue homogenate on MB agar plates and based on 16S rRNA gene sequencing and blast search, this strain was found to be a potential novel genus showing 95% similarity to *Fabibacter halotolerans* under the family Flexibactericeae.

Another orange pigmented strain C144 isolated from the branching coral *Pocillopora* sp. was identified as *Microbacterium arborescens* based on phenotypic characteristics. The strain is characterized by its ability to produce strongly pigmented orange colonies and could be a potential source of carotenoid pigments.

Series of underwater surveys were conducted along the Saurashtra coast of Gujarat and in selected spots of Gulf of Kutch Marine National Park. At Jaleswar and Poshitra sporadic bleaching of corals were noticed. Survey site Jaleswar was very near to the Rayon industries of Veraval and the presence of chemical effluents was one reason for the beaching of corals. The coral discolouration found at Poshitra was due to the highly saline effluents of salt pan bordering that area. Zooanthids were predominant in certain sites of the National Park.



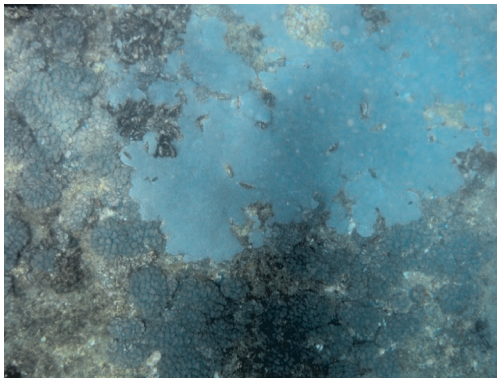
Goniopora sp.



Favia sp.

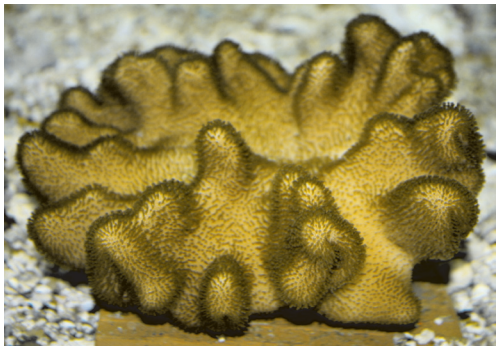
Zooanthids

Underwater photographs in selected spots of Gulf of Kutch Marine National Park

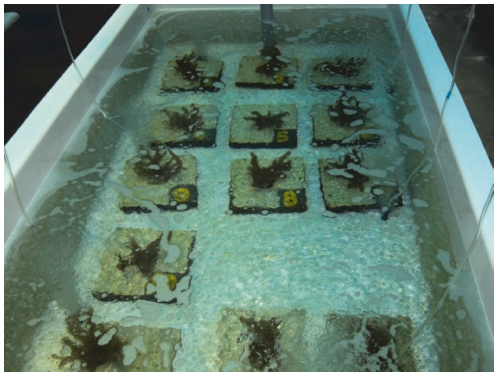


Encrusting zooanthids - Enayam

Photograph of the colony of *Lobophytum hirsutum* from the hatchery.



Lobophytum sarcophytoides in hatchery.



Propagation of *Sinularia* sp. in hatchery

Soft corals

Recent studies related to the shallower reef area of the Palk Bay in the vicinity of Thankachimadam near Villundy revealed the presence of a new distributional range in the species of the genus *Lobophytum*. The growth and morphology of the colony distinguished by sclerite characteristics and the microphotographs in different size compositions identified the species as *Lobophytum hirsutum* Tixier-Durivault, 1956 which was collected by SCUBA diving from a depth of 3 to 5 m. The species was conspicuous with finger like lobes and narrow stalk and was reported earlier from the waters off Vietnam, South and Middle Andamans.

Lobophytum sarcophytoides Moser, 1919 was recorded from the shallow reef area of the Palk Bay. The colony is bowl shaped with marginal open raised folds exhibiting digitiform and crest-like lobes; the surface layer of stalk and lobes are quite different. Clubs with a central wart or irregularly placed warts and prominences on the handles are arranged in one or two girdles.

Propagation studies on soft corals at Mandapam

Propagation of Sinularia sp. *in the laboratory*

A total of 20 fragments were taken utilizing 4 parent colonies. The substratum used for attachment was the concrete blocks. The time taken for attachment of fragments to the substratum was 2 weeks. The mean increase in basal circumference after complete establishment of the colony to the new substratum was 16.71 mm in 30 days. The mean increment in the number of lobes after complete establishment on to the new substratum was 4.3 in 30 days.

A total of 10 fragments of *Sinularia* sp. were established on to tiles. The tiles served as an excellent substratum for attachment of the fragments and it took about 2 to 3 weeks for complete attachment to the substratum and the survival rate was 100%.

Propagation of Cladiella sp. *in the Laboratory*

Cladiella sp. is an extremely beautiful and an ornamental soft coral. Propagation studies were attempted on this species. The substratum like concrete blocks, tiles, coral rubbles and oyster shells were used and all these types of substratum were found to be successful in achieving quick attachment, survival and growth. A total of 25 colonies were developed with 100% survival. The average increase in the number of lobes was 20.8 in a culture period of 90 days in the laboratory.

Sponges

Intertidal surveys revealed rich sponge resources in certain areas of Gulf of Mannar and Palk Bay *viz*., Shangumal, Thonithurai, Koilvadi, Chinnapalam, Devipattinam, Thirruppalaikudi. The dominant species in the intertidal region of Shangumal, Chinnapalam and Koilvadi is *Spirastrella inconstans*. Diverse sponge species were observed in the gill nets (*singhi valai*) having a mesh size of 110 mm, operated 9 km away from the shore off Vethalai at a depth of 10-11m. The studies revealed destruction of sponges and other invertebrates by gill net operations, particularly singhi valai which is operated for catching lobsters. Over twenty species of sponges are observed in these fishing nets. The non-target resources like some gastropods, crabs, star fish and sponges are landed in large quantities

Sponges of the coral reef ecosystems along the south-west coast of India

For understanding the sponge resources and the threats they face underwater surveys conducted in previous years in the shallow coastal waters extending from Enayam to Kollam, southern India revealed a total of 24 species of sponges which were identified during the study and belonged to 20 genera, 13 families and 6 orders. Maximum species diversity was recorded at Enayam (11 species), followed by an equal number of species at Vizhinjam and Adimalathura (10 species). A majority of sponge species at Enayam, Vizhinjam and Adimalathura were found to be associated with the mussel beds.

Reef fish

Coral reef fish assemblages associated with patchy reefs along Enayam-Kollam waters in Southern India reinvestigated by using Visual Census Method revealed a total of 48 species of reef fishes belonging to 31 genera, and 20 families. Maximum species diversity was recorded at Thankassery (23 species), followed by Vizhinjam (20) and Varkala (20 species). In abundance, fishes of the family Pomacentridae (57%) dominated the sites followed by Chaetodontidae, Lutjanidae, Apogonidae, Ballistidae, Siganidae, Scaridae, Acanthuridae, Labridae, Pomacanthidae, Carangidae, Mullidae, Holocentridae, Mugilidae, Muraenidae, Zanclidae, Serranidae, Ostraciidae, Scolopsidae and Haemulidae.

The reef fishes landed at Pamban Therkuvady, Pamban Light House, Mandapam and Keelakarai were monitored. A total of 196 species belonging to 53 families were recorded of which, the maximum numbers were contributed by trawl, followed by traps, bottom set gillnets and the least

Genera and species distribution in different families of reef fishes observed in the visual Census Method along southern India (Enayam to Quilon)

Family	Genus	Species
Acanthuridae	1	4
Apogonidae	1	2
Balistidae	3	3
Chaetodontidae	2	5
Carangidae	1	1
Haemulidae	1	1
Holocentridae	1	1
Labridae	5	5
Lutjanidae	1	4
Mugilidae	1	1
Mullidae	1	1
Muraenidae	1	2
Ostraciiidae	1	1
Pomacanthidae	2	2
Pomacentridae	3	8
Serranidae	2	3
Scaridae	1	1
Scolopsidae	1	1
Siganidae	1	1
Zanclidae	1	1

Genera and species distribution in different families of reef fishes of Tuticorin area of GoM

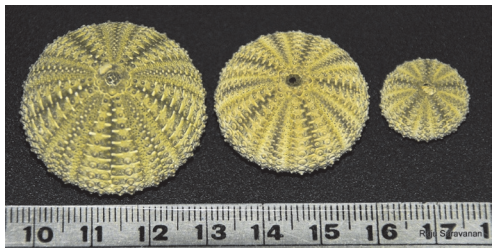
Family	Genus	Species	Family	Genus	Species
Acanthuridae	4	12	Lutjanidae	2	3
Albulidae	1	1	Malacanthidae	1	1
Antennariidae	1	1	Monacanthidae	2	3
Balistidae	5	11	Monodactylidae	1	1
Belonidae	3	5	Mugilidae	1	1
Caesionidae	1	3	Mullidae	3	4
Carcharinidae	1	2	Muraenidae	3	7
Carangidae	7	12	Nemipteridae	1	2
Carapidae	1	1	Ostraciidae	2	5
Chaetodontidae	3	17	Pempheridae	1	2
Chirocentridae	1	1	Pomacanthidae	3	5
Congridae	2	2	Pomacentridae	4	7
Dasyatidae	2	2	Priacanthidae	1	1
Diodontidae	1	1	Sauridae	1	1
Drepaneidae	1	1	Scaridae	4	10
Ephippidae	1	1	Scorpaenidae	3	5
Fistularidae	1	1	Serranidae	2	9
Ginglyostomatidae	1	1	Sparidae	1	1
Haemulidae	3	8	Spyraenidae	1	2
Hemiscyllidae	1	1	Synganthidae	2	5
Holocentridae	1	1	Synodontidae	1	1
Kyphosidae	1	1	Terapondidae	2	2
Labridae	11	24	Tetradontidae	2	7
Lethrinidae	1	6	Zanclidae	1	1

number of species was contributed by hooks & lines. Quantitatively, the trawl landings formed the maximum.

Astropecten indicus

A total of 202 species of coral reef fishes belong to 110 genera were studied from the Tuticorin area of Gulf of Mannar during the period 2008-2011. Biodiversity indices of 48 families in relation to the species present in different families and biodiversity indices were estimated. Maximum species diversity was observed in the families of Labridae (24) Chaetodontidae (17), Carangidae (12), Acanthuridae (12), Scaridae (10) and Serranidae (9).

Few new records in the family of Carapidae were observed in the Tuticorin area of Gulf of Mannar. Most common species of Labridae recorded from Tuticorin area were *Cheilio inermis, Chelinus trilobatus, Chelinus chlorourus, Chelinus oxycephalus, Coris gaimardi, Coris formosa, Halichoeres centriquandrus* and *Halichoeres hartzfeldi.* The fishing gears employed for exploitation included almost all the gears like trawl nets, shore seines, Thallumadi (minitrawl), different types and varieties of hook and lines and gill nets of different mesh sizes and materials.



Temnopleurus toreumaticus

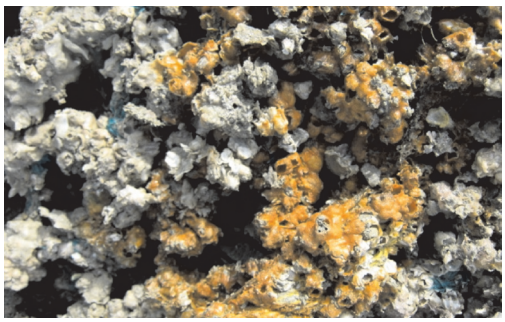
Other resources

Nine species of star fishes were collected and identified from Gulf of Mannar and Mangalore waters. Sand star species *Astropecten indicus* Doderlein, 1888 was received in good numbers in the single day trawl catches whereas another sand star species *Archaster typicus* Müller & Troschel, 1840, was observed in the trawl discards in Mandapam waters. Three species of sea urchins collected and identified from Mandapam waters were identified as *Salmacis virgulata* L. Agassiz & Desor, 1846,

Clypeaster rarispinus

Lovenia elongata (Gray, 1845) and *Echinolampas ovata* (Leske, 1778). Sea urchins collected from trawl discards and from the exploratory fishing operations along the Mangalore coast was dominated by a single species *Temnopleurus toreumaticus* (Leske, 1778). Two species of sand dollars *Clypeaster* rarispinus de Meijere, 1903 were recorded in Mangalore coast along with the Malabar sole catches. *Peronella orbicularis* (Leske) was recorded in Mandapam trawl discards. Two species of Scyphomedusae, *Lychnorhiza malayanus* Stiasny 1920, and *Acromitus flagellates* were documented from Mulki Estuary and Netravati-Gurupura along Karnataka coast. The jellyfish survey revealed that the *Acromitus flagellates* swarm has been delayed by a month this year in Netravati-Gurupura Estuary. Ten species of marine finfishes have been documented for the first time along Mangalore coast in addition to the already documented 412 species earlier at Mangalore. This has increased the alpha diversity of the marine finfishes of this coast to 422.

Biodiversity and ecological changes in sea cage farming area Mandapam



Thick mat of barnacles on cage net

At Mandapam, the analysis of water quality parameters indicated no significant changes between the cage and the control sites. The water quality was found to be ideal throughout the year with no adverse changes in the cage farming sites. The textural analysis of sediment revealed a higher percentage of sand grains in both the sites.

A total of 38 genera of phytoplankton were identified from both the cage and control sties. The rate of fouling was found to be extremely high in the Gulf of Mannar waters and the dominant fouling community was the barnacles. The barnacles often form a very thick mat on the cage nets and smaller the size of mesh, the barnacle infestation is more, adding tremendous weight to the cage nets and minimizing water exchange to the cages. The other major fouling organisms include the rock oysters, pearl

oysters, sponges, seaweeds, Ascidians and *Modiolus* sp. The high rate of fouling compels for regular cleaning of cage nets and frequent net exchanges to keep the fishes healthy.

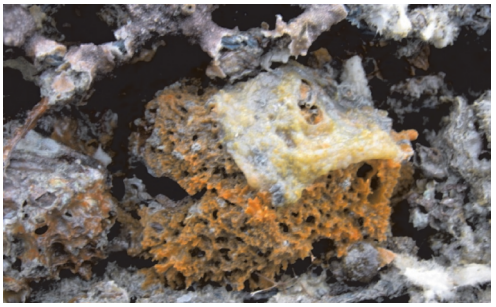
The entrant animals include the lion fish, banner fish, lobsters, crabs and shrimps (*Hippolysmata* sp.). The lobsters enter the cage nets during juvenile stages and grow to large size due to availability of food. The common crabs found in the cage nets include *Plagusia squamosa, Hyastenus diacanthus, Nanopilumnus rouxi* and some porcellanid crabs.

The traditional fishing gear locally called Patti valai are operated very close to the cage farm and therefore regular observations were made on the fish catches of *Patti valai* to understand the richness of fish assemblages in the cage farm area. The common fishes include *Sardinella longiceps, S. albella, Gerres filamentosus, Psammoperca waigiensis, Rastrelliger kanagurta, Leiognathus dussumieri, Siganus javus, S. canaliculatus*, Puffer fishes, *Johnius carutta, Lutjanus rivulatus, L. fulviflamma, L. fulvus, Lethrinus nebulosus, Plotosus* sp., *Pempheris* sp., *Upeneus tragula, Parupeneus indicus, Alepis* sp., *Seleroides leptolepis, Plectorhinchus* spp., *Canthygaster solandri, Gnathonodon speciosus, Scarrus ghobban, Therapon sp., Heniochus acuminatus, Chaetodon collare* and *Abudefduf* spp.

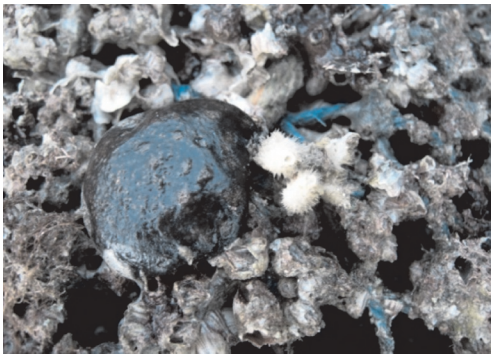
Vizhinjam

At Vizhinjam, in the cage site, the average values for sea surface temperature ranged from 26 °C in July and September to 28 °C in May. The salinity values varied from 35 to 37 ppt in both cage and control sites. The water pH ranged from 7.65 to 8.2 in the cage site and from 7.68 to 8.2 in the reference site. The dissolved oxygen content was low during August in the cage site, while the low values for dissolved oxygen in the reference site was recorded during the month of June. The sediment pH varied from 7.61 to 7.88 in cage site to 7.62 to 7.88 in the reference site. The sediment is highly silty in the cage site and sandy in the reference site. Thirty eight genera of phytoplankters were recorded from the study sites, comprising both the cage and reference sites. They were *Asterionella, Chaetoceros, Rhizosolenia, Thallasiothrix, Biddulphia, Coscinodiscus, Thalassiosira, Thalassionema, Nitzschia, Pleurosigma, Fragilaria, Triceratium, Ceratium, Dinophysis, Eucampia, Peridinium, Stephanophyxis, Grammatophora, Bacteriastrum, Hemidiscus, Planktoniella, Ditylum, Protoperidinium, Pseudonitzhia, Actinotychus, Stephanodiscus, Ceratulina,* and *Trichodesmium*. A total of 16 groups of zooplankters were recorded from the cage and reference sites. They were copepods, chaetognaths, cladocerans, decapod larvae, fish eggs, fish larvae, *Lucifer* sp., amphipods, gastropods, polychaete larvae, cumaceans, mysids, cirripede larvae, ostracods and salps. The copepods dominated the zooplankton biomass in both the sites, predominantly represented by the genera *Pseudodiaptomus, Acartia, Temora* and *Oithona* followed by chaetognaths, *Lucifer*, fish eggs and larvae and decapod larvae. Macrobenthos abundance was less in the reference site than in the cage site. The dominant macrobenthos in the cage site were amphipods, bivalve shells, gastropods, polychaetes, copepods, nematodes, sipunculids and algae. In the control site, bivalves formed the dominant group, while copepods were recorded in meager numbers.

A rich assemblage of fishes was observed around the cages which included carangids such as *Carangoides armatus, Caranx sexafasciatus, C. heberi, C. malabaricus, Alectis indica, Alepes djedaba;* mullet *Liza macrolepis;* parrot fish, *Chlorurus sordidus;* rabbit fishes, *Siganus canaliculatus, Siganus javus; snapper, Lutjanus fulviflamma;* spotted sickle fish, *Drepane punctata;* bat fish *Platax* sp., Pharaoh cuttlefish, *Sepia pharaonis*; squid *Sepioteuthis lessonian*. During the monsoon period, the dominant ornamental fishes were the butterfly and



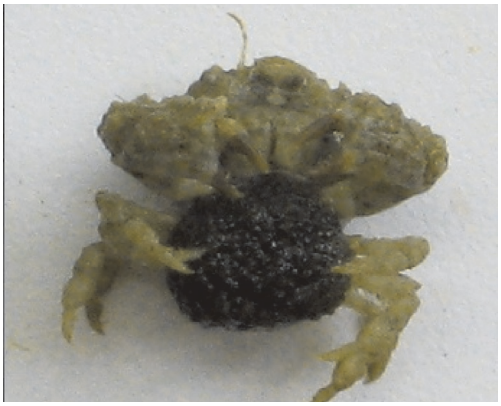
Sponge attached to cage net



Ascidians and sponges on the net

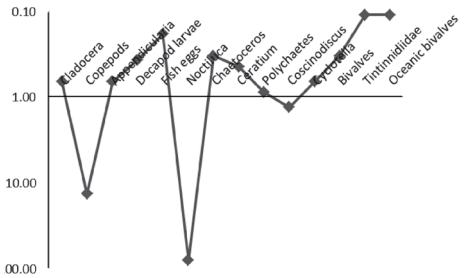
Thick mat of seaweeds infesting the net

Hyastenus diacanthus

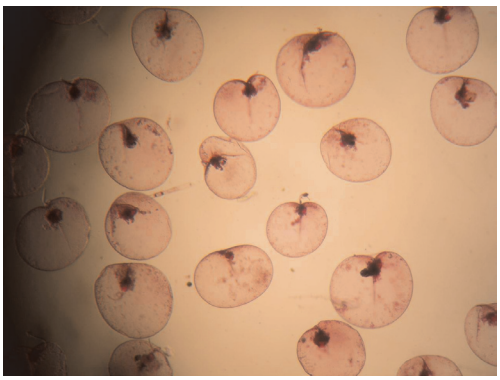


Nanopilumnus rouxi

Plagusia squamosa



Plankton composition in the Karwar cage culture site during the peak *Noctiluca scintillans* bloom in 2011



Noctiluca scintillans bloom in Karwar cage culture site in 2011

banner fishes (Chaetodontidae), Sergeant major and damsels (Pomacentridae - *Abudefduf sexatilis*, *A. sordidus, A. bengalensis*) and snappers (Lutjanidae) and in September siganids were the dominant ones. Experimental panels made of PVC pipes (15cm x 15cm) with 2cm mesh netting were suspended to study the fouling communities. A total of 62 panels were suspended. The panels were analysed from February onwards. The average weight of panels which was 180 g in February increased to 390 g in October. The most common species of foulers were sponges, colonial ascidians, solitary ascidians, hydroids, serpulid worms, barnacles, nematodes, oligochaetes, polychaetes, foraminiferans, harpacticoid copepods, amphipods, brittle stars, brown mussel, rock oysters, pearl oysters, seaweeds, isopods and small crabs. The main increase in weight was due to barnacles, mussels, oysters and sponges.

Karwar

At Karwar, fourteen different planktonic organisms were found during the study *viz*., cladocerans, bivalves, tintinnids, copepods, polychaetes, appendicularians, decapod larvae, fish eggs, *Noctiluca, Chaetoceros, Ceratium, Coscinodiscus* and *Cyclotella*. There was an intense bloom of dinoflagellate, *Noctiluca scintillans* (Macartney) in June/July month, and this was followed by copepods and *Coscinodiscus* sp. Among the benthos, gastropods were the dominant group contributing nearly 61% followed by polychaetes (19%) and bivalves (16%).

The bacterial load of the sediment at the cage site was significantly higher than the reference site throughout the year, except during October to December. Further, the CFU/g was significantly lowest both in reference and cage sites during December, compared to rest of the months. Highest CFU/g in both reference and cage site was observed in August. The bacterial load of the cage water was significantly higher than the reference water during August, September and October when compared to rest of the months. While, the CFU/ml of the cage water was highest in August, reference water showed highest CFU/ml in February. In both cage and reference sites, the CFU was least in May.

Biodiversity valuation of marine ecosystems of the southwest coast of India

List of important marine organisms *viz*., *species* wise, genera wise and family wise were prepared. Species, genera, family and order list of the important marine organisms (fish, turtles, mammals, echinoderms, medusae, shrimps, lobsters, crabs, corals, sponges, ascidians, zooplankton and phytoplankton) were prepared. Consolidated list of 57 species of shrimps belonging to 22 genera and 9 families, 152 species of crabs of 86 genera and 20 families and 9 species of lobsters of 3 genera and 3 orders, 112 species of echinoderms belonging to 70 genera and 35 families, 91 species of sponges belonging to 45 families, 34 species of gorgonids belonging to 10 families 508 species of phytoplankton belonging to 27 and 465 finfish species belonging to 212 genera were prepared for the valuation purpose. The preliminary economic valuations of fishery resources were done collecting data on direct value, indirect value and other values. Total fish catch form the area was about 517592 t which included crustaceans, molluscs and miscellaneous groups which was taken for the estimation of direct value of resources. Total number of fishermen population was 602 234 of which 124103 were engaged full time, 10488 as part time also formed the basis for valuation. Total number of crafts was 29 177 of which 3982 trawlers, 54 purse seiners, 428 gillnetters and 443 rings which formed the basis for labour valuation.

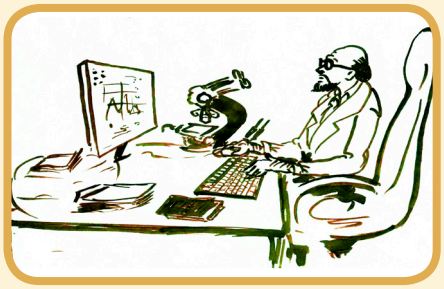
Bioinventorisation of coral fishes of south India with special reference to threats and conservation measures

Documentation of coral reef fishes of South India as well as Lakshadweep islands was carried out during 2011 and 92 species under 18 families, of reef fishes were recorded from hooks and lines, gill nets, trawlers, traps and hand nets operated from the major and minor landing centres of South India as well from traditional gears.

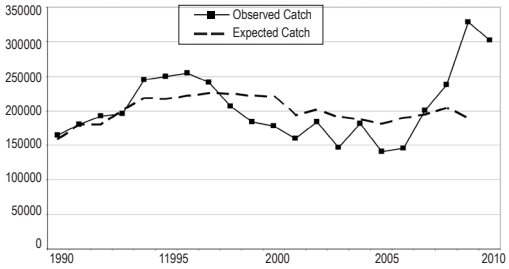
Monsoon fishery survey was also done in Agatti island of Lakshadweep. The major gears operated were '*OalaVala*' and meshed gill nets.The dominant families recorded were Acanthuridae, Labridae, Haemulidae, Balastidae, Mullidae, Serranidae, Pomacentridae and other minor families recorded were Siganidae, Kuhliidae, Holocentridae, and Pinguipedidae

Occurrences of IUCN listed Near threatened/ Vulnerable species in the fishery was also recorded.

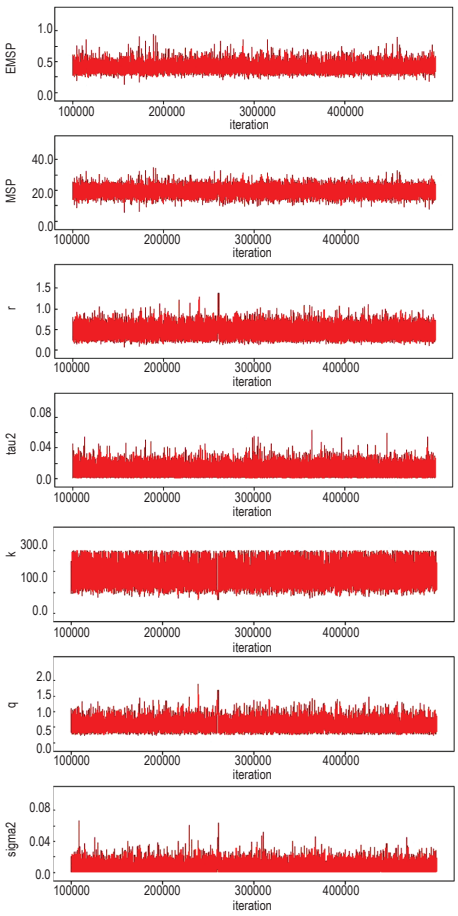
The four new records from Indian Ocean are: *Myripristis greenfieldi, Myripristis seychellensis, Plectropomus laevis, Hyporthodus octofasiatus*



Fisheries and Ecosystem Modeling



Schaefer's non-linear model estimated by genetic algorithm for Kerala trawl fisheries data.



History of Markov Chain Monte Carlo (MCMC) simulations for estimation of posterior densities of non-linear Schaefer model parameters for trawl fishery in Kerala

Decision support systems for management of trawl fisheries

Bayesian estimation method was adopted to study catch and effort time series for trawlers in four states. Schaefer's non-linear model was considered for arriving at estimates of posterior probability densities of model parameters, biomass indices and MSY. Towards finalising the proper priors, non-linear state space models were fitted for catch and effort time series for Kerala, Karnataka, Tamil Nadu and West Bengal. Genetic algorithm based estimation for the Kerala trawl fisheries data yielded a near perfect matching with some divergence towards the end. A common procedure with the following specificities was adopted towards estimating the posterior distributions of parameters.

1) The algorithm used was Markov Chain Monte Carlo (MCMC) using Gibbs Sampling
2) Software used is WinBUGS version 3.0.3
3) Total number of replications made: 5 lakh for each data set.
4) Initial One lakh iterations left out to ensure convergence.
5) Prior distributions for carrying capacity (K) and intrinsic rate of growth (r) assumed to be log normal distributions
6) Prior distributions for catchability coefficient (q) and the process and observation error variances were assumed to be inverse gamma with suitable parameters.
7) Prior distribution parameters were computed by 10% and 90% quantiles and the calculations were made using alpha-beta solver.

The Bayesian estimates of the indicators and reference parameters of trawl fishery of four maritime states of India were estimated along with their 95% confidence intervals. The final estimates of Maximum Sustainable Yield (MSY) for the trawl fishery resources was arrived at for Kerala (1,98,700 t), Karnataka (2,02,200 t), Tamil Nadu (2,11,000 t) and West Bengal (46,510 t) with the decadal actual landing averages of Kerala, Karnataka and Tamil Nadu being less than the estimated MSY.

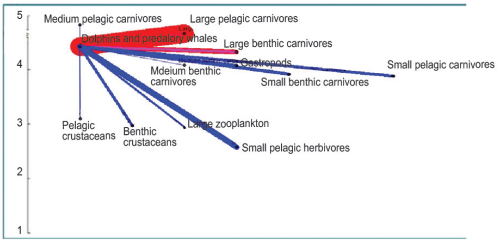
Trophic model of the Gulf of Mannar Ecosystem

The recently developed trophic model of the Gulf of Mannar (GOM) had 32 ecological groups. Most groups were not predated upon and also were not fished in the ecosystem. Fishing mortality was highest for small and large reef fishes and medium benthic carnivores. In most exploited groups, predation was the main source of mortality. In order to understand the scale

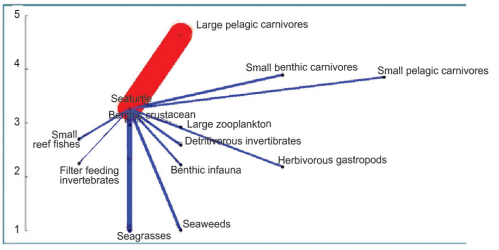
and magnitude of the predation taking place in the ecosystem, the GOM model was used to assess the predation strengths of all ecological groups.

The predation strengths are primarily based on the qualitative and quantitative diet data scaled by biomass of different ecological groups. The RED bars indicate predation by and BLUE bars indicate predation on and the thickness of the bars indicates the relative strength of the predation.

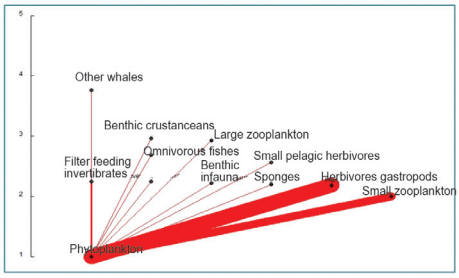
The analysis shows that the major predatory group, dolphins and predatory whales predates on a wide variety of pelagic and demersal carnivores and herbivores including pelagic crustaceans like swimming crabs. It is predated only by large pelagic carnivores during its very young stages. Similar is the case of turtles which also feed substantially on sea plants. In the case of phytoplankton, they are predated by a wide variety of organisms, including other whales (baleen).



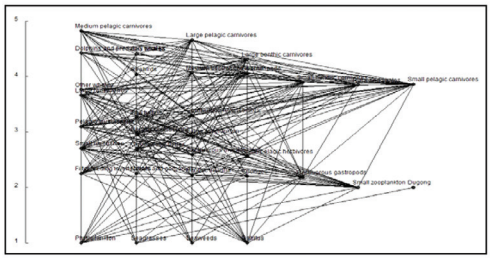
Dolphins and predatory whales



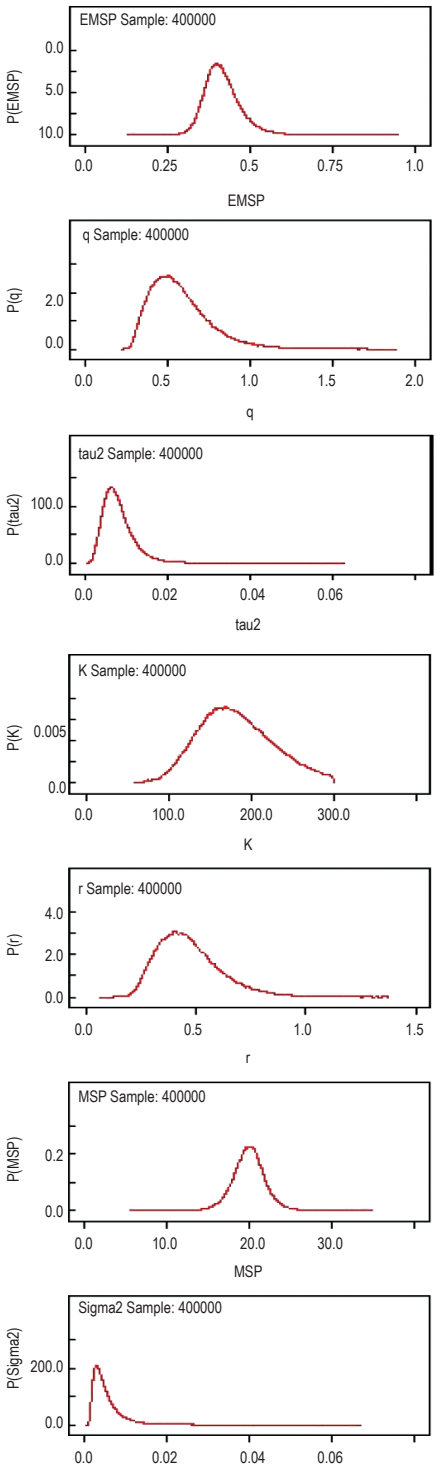
Sea Turtles



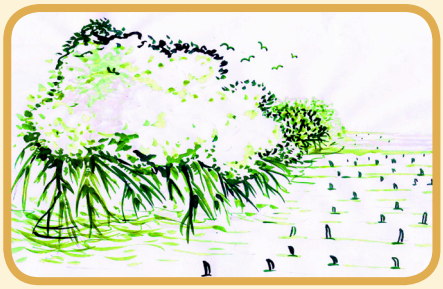
Phytoplankton



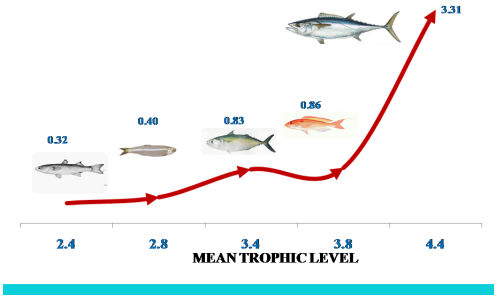
Network diagram showing the trophic level based connectance between different ecological groups



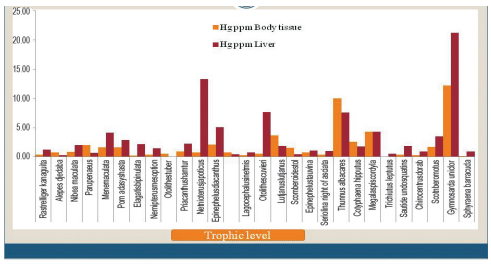
Estimated posterior probability densities of non-linear Schaefer model parameters and Maximum Sustainable Production (MSP) for trawl fishery in Kerala.



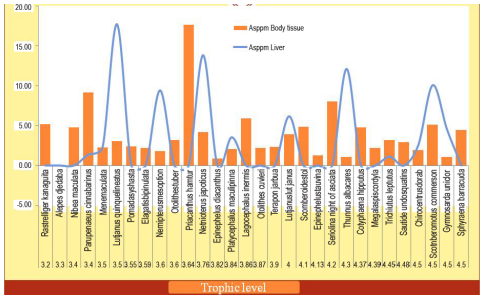
Marine Habitats



Bio-magnification of mercury (μg g^{-1}) along the trophic food web of Southwest coast



Bioaccumulation of mercury in tissue and liver of seleceted trophic level species along the south west cost



Bioaccumulation of arsenic in tissue and liver of seleceted trophic level species along the south west cost

Ecosystem health: heavy metal pollution

Level of mercury and arsenic in selected finfishes, crustaceans and molluscs, sampled from Tuticorin, Chennai, Visakhapatnam, Mumbai, Mangalore, Calicut and Kochi were found to have concentrations within the permissible levels prescribed by the WHO.

Assessment of biomagnifications of arsenic and mercury in the ecosystem

Level of mercury and arsenic in 49 species of marine resources which are commonly found in the food chain in the southwest region were analyzed. All commonly occurring fishes which were fished from southwest coast (eg. sardine, mackerel, anchovies, etc) were found to be safe for consumption.

Mercury concentrations in mean trophic levels 2.4, 2.8, 3.4, 3.8 and 4.4 were estimated as 0.32, 0.40. 0.83, 0.86 and 3.31 μg g^{-1} respectively. Though belonging to higher trophic level (4.0 to 4.5), species like *Epinephelus tauvina, Seriolina nigrofasciata, Saurida tumbil, Trichiurus lepturus, Saurida undosquamis, Chirocentrus dorab, Sphyraena jello, Scomberomorus commerson, Caranx sexfasciatus, Sphyraena barracuda* were found to have very low levels of Hg, all within permissible limit.

Bioaccumulation of mercury and arsenic in selected species along the southwest coast

Bioaccumulation of mercury in the liver was observed in 64.2% of fishes. However, in the tissue of these species, the levels of mercury were below detectable level (BDL). Though within permissible limit, maximum bioaccumulation of mercury was in the liver (13.29 μg g^{-1}) of *Nemipterus japonicus* which was 17.47 times than that in tissue (0.76 μg g^{-1}).

Bioaccumulation of arsenic was observed only in 30% of the fishes. However, both in the tissue and in the liver, levels of arsenic were within permissible limits

Evaluation of mercury and arsenic in clam beds of Ashtamudi Lake

A comprehensive survey was conducted to estimate the level of mercury in the sediment of Ashtamudi Lake, Kerala where clams are fished for domestic and international markets. The sampling stations were between 8^0 56' 967"N 76^0 33' 574"E and 8^0 59' 642"N 76^0 35' 072"E and samples were taken from 20 sites.

In all the clam samples *(Paphia malabarica)*, the level of mercury was within the permissible limit. As per NOAA guidelines for sediment quality,

the Probable Effect Level (PEL) for Hg is 0.7 ppm. Mercury was not present in any of the sediment samples.

Ecosystem health: Coastal pollution monitoring
Monitoring of water quality in effluent outfall regions

Due to disposal of raw domestic sewage in the coastal areas of Tuticorin (Threspuram area) dissolved oxygen levels were hypoxic (0.29 + 0.7ml l^{-1}) and in these sites increase in ammonia levels (1.5 + 0.6 mgl^{-1}) and CO_2 (22.5 + 5.1mgl^{-1}) was observed.

Continuous monitoring of the water quality was done at different locations along Maharashtra (Versova, Mahim, Gorai, Juhu) and in these sites wide variation in salinity was observed (3.82 to 33.50 ppt); dissolved oxygen values were between 0.28 mg l^{-1} and 3.12 mg^{-1}, B.O.D. ranged between 4.0 to 10 ml l^{-1} at Versova, Chlorophyll-a ranged between 0.03 mg m^{-3} to 21.49 mg m^{-3}.

Four coastal stations Chitrapur, Panambur, BASF and Thaneerbhavi along Mangalore coast to assess the impact of industrial effluents. The annual variation in water quality parameters in coastal waters did not show unusual values. Seasonal difference in hydrological parameters was observed.

The water quality in the outfall area of the industrial belt of Ernakulam district was found to be very poor. The pH of the water was found to be acidic in the observations since 2004. The dissolved oxygen levels were either hypoxic or anoxic especially at Irumpanam during the last two years. The study indicated an urgent need to improve the environmental conditions near the industrial area

Marine litter collected during fishing in the region off Mumbai.

Ecosystem health: Marine litter

Along Tuticorin coast, the quantity of non-biodegradable substances was highest at the Threspuram beach and ranged between 100 – 750 g m^{-2} followed by Tuticorin harbour beach (313 ± 62.1 g m^{-2}) and Tharuvaikulam beach (73.8 ± 16.3 g m^{-2}). The Mottaigopuram beach recorded the least value, 72.5 ± 17.2 g m^{-2}.

Quantity of plastics strewn around beaches along Calicut coast ranged from 0-10 g m^{-2} in Thikkodi, 10-24 g m^{-2} in Beypore and 5-12 g m^{-2} in Konnad. In Konnad fishing ground, plastic obtained was 30-62.5 g per trawl.

Along Mangalore coast, plastics were monitored on three beaches Chitrapur, Panambur and Thaneerbhavi. Thaneerbhavi had the highest rate of marine litter of 530 g m^{-2} $month^{-1}$ followed by Chitrapur 402.9 g m^{-2} $month^{-1}$ and Panambur 204.9 g m^{-2} $month^{-1}$. The items in the marine litter were mainly ice cream spoons, caps, toothbrush, plastic straw, small bottle caps, plastic sachets, nylon ropes, plastic mats, slippers, shoes, thermocole, sponges etc. The size of the plastic debris ranged from 0.01 cm to 200 cm.

Along the central Kerala coast the marine litter distribution in different beaches (g m^{-2}) varied. Along Maharashtra, considerable quantity of non-biodegradable waste was obtained in different fishing gear.

Marine litter collected in stake nets are thrown back to the sea

Participatory approach in marine litter assessment in ecosystem

An assessment of the litter flowing to the Arabian Sea was made with the help of stake net fishers. The quantity of litter flowing into the coastal ecosystem was found to be considerably higher during the full moon and new moon period coinciding with the spring tides. It was estimated that during the pre-monsoon period, each month approximately 204 kg of marine litter enters the Arabian Sea through the bar mouth at Moothakunnam.

The survey clearly indicated the need to create awareness about the negative impacts of marine litter on the environment and fishery resources.

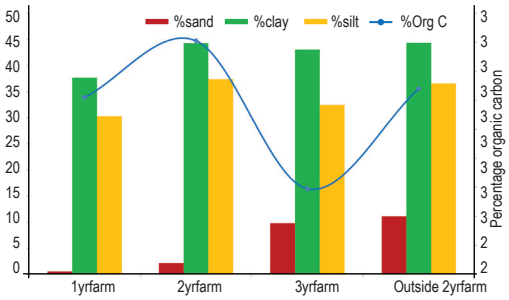
Ecosystem health: Impact of bivalve farming

Trophic level change in Padanna estuary

Diurnal oxygen curve constructed using open method and the simultaneous *in situ* incubation of water samples on closed method carried out during December 2010, March 2011 and October 2011 in the Padanna estuary (Thrikaripur) indicated heterotrophic conditions during the active mussel farming seasons.

P/R values of Padanna estuary determined using diurnal oxygen curve and the GPP determined through closed *in situ* incubation system

Period of observation	P (O_2 ml l^{-1} day^{-1})	R (O_2 ml l^{-1} day^{-1})	P/R	GPP (g C m^{-3} day^{-1})
19-12-2010	P 0.196	R 0.322	0.608	0.546
1-03-2011	P 0.820	R 1.030	0.796	0.102
16-10-2011	P 4.569	R 2.367	1.930	1.20



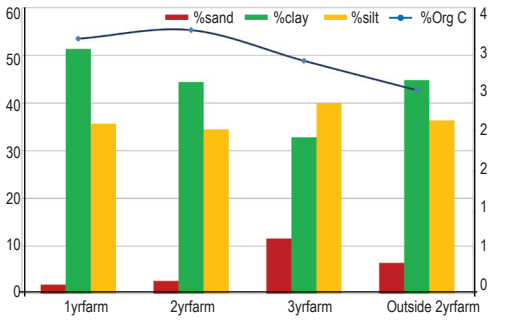
Impact of bivalve farming on the sediment texture and organic carbon in the top 0-5 cm layer.

Impact of bivalve farming on the benthos, soil characteristics and organic carbon

The assessment of impact of bivalve farming on the benthic faunal communities indicated that species richness (d) and diversity index H'(loge) was higher in the second (F2) and third (F3) year farm sites. Copepods dominated in the first year farm (F1) benthic community, while in F2 and F3, *Polydora capensis* dominated.

The percentage of organic carbon was high at F1 and F2, but decreased in the F3 farm. This indicates that there are no long term negative impacts of farms. There was a steady increase of sand component at different farm sites.

It was observed that when the farms are very near, with less than 10 m between two farm structures, the open region between the two farms is impacted by both the farms. Hence there is a need to fix the minimum space between two farms.



Impact of bivalve farming on the sediment texture and organic carbon in the 5-10 cm layer.

The impact of bivalve farming on the benthos beneath a one year farm (F1), two year farm (F2), three year farm (F3) and the control (C)

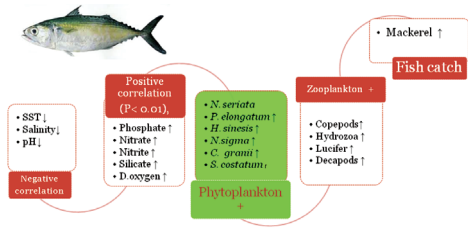
	F1	F2	F3	C
No. of species (S)	3	7	7	4
Total Individuals (N)	508	667	452	98
Species richness (d)	0.321	0.923	0.981	0.655
Species evenness (J')	0.622	0.867	0.980	0.959
Diversity Index H'(loge)	0.684	1.687	1.906	1.330
Simpson Index 1-Lambda'	0.371	0.780	0.846	0.730

Fishery enviornment and fish catch

The hydrological characteristics of the fishing area were studied in detail and 17 different environmental parameters were collected from the coastal fishing area. An attempt was made to analyse the relationship between abiotic factors, productivity and fish catch. Detailed analysis of the phytoplankton and zooplankton were also carried out.

Correlation of environmental parameters with fish catch

Analysis of the hydrological parameters, the productivity factors and the catch by gears operating in the near-shore area off Kochi indicated that there is a negative correlation in SST ($p<0.01$), salinity ($p<0.05$) and pH ($p<0.05$) with mackerel catch. The mackerel catch showed positive correlation with DO ($p<0.01$), silicate ($p<0.01$), phosphate ($p<0.01$), nitrate ($p<0.05$), nitrite ($p<0.05$), chl a ($p<0.01$) and chl b ($p<0.05$). The corresponding increase in phytoplankton such as *Nitzschia seriata, Pleurosigma elongatum, Hemiaulus sinensis, Nitzschia sigma, Coscinodiscus granii* and *Skeletonema costatum* leads to increase in copepods, hydrozoa, Lucifer and Decapods. Such a combination leads to increased catch of mackerel in near shore gears.



Pictorial representation of the relationship between environmental variations, plankton abundance (food for fish) and the catch of Indian Mackerel off Kochi

Along Mangalore coast, mackerel catch was found to be negatively correlated ($p< 0.05$) with SST. Along Mangalore coast, mackerel landings was found to be positively correlated with salinity and chlorophyll a ($p<0.01$) and negatively correlated with dissolved oxygen ($p<0.01$). During upwelling period, the DO of bottom water is low. Mackerel catch showed positive correlation with silicate. As near shore the influence of the discharge of rivers brings in more silicate during monsoon.

The oil sardine catch in the region off Kochi showed a negative correlation (($p<0.05$) with pH and a positive correlation with chl b ($p<0.01$). Oil sardine catch along Mangalore was negatively correlated with SST and silicate ($p<0.05$). *Stolephorus* (Anchovies) catch was positively correlated with chlorophyll a and nitrite ($p<0.01$) in the region off Mangalore.

Algal blooms and zooplankton swarms in the fishing areas along the west coast

Toxic bloom of *Chattonella marina* was observed during 27-9-2011 to 17-10-2011 at varying intensities along the entire Calicut coast. Dissolved oxygen levels in the bloom area were low (1.899 O_2 ml l^{-1}) in the morning hours but recovered (3.087 to 4.275 O_2 ml^{-1}) after the noon hours. Mass mortality of fingerlings of *Otolithes* sp. *Cynoglossus* sp. and *Liza* sp and mole crab *Emerita asiatica* was observed in association with the bloom.

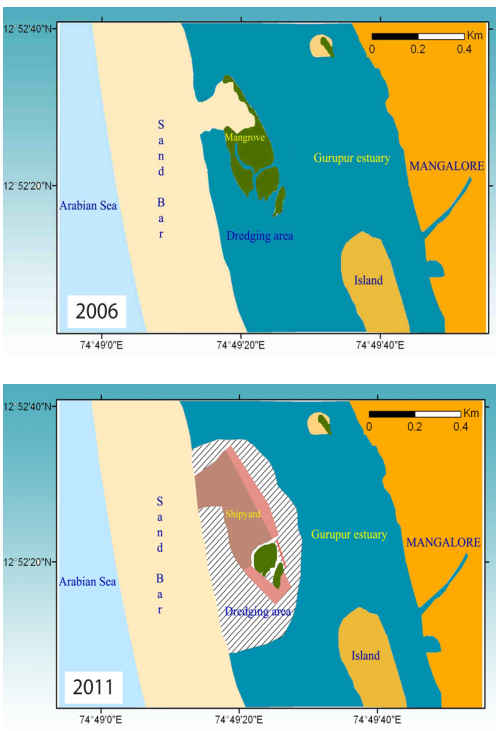
A bloom of *Noctiluca scintillans* (Macartney) with a cell density of 10.5 lakh cells l^{-1} was observed along the Mangalore coast on 12.05.2011. It extended from Mangalore bar mouth area to Sasihithlu spanning a distance of about 15 km and to about 2 km towards west rendering the sea surface a greenish tinge.

Marine habitats: Evaluation and restoration programs

Extent of clam and mangrove habitat loss in Karnataka

The Gurupur estuary along the southern part of Karnataka is an important bivalve fishing centre. Since 2007-2008, dredging activities in Bengre for reclamation of sand bar and mangrove areas has resulted in the destruction of bivalve beds and mangroves. A survey was conducted to estimate the extent of habitat loss due to anthropogenic activities.

The historic extent of clam bed in 2006 was estimated as 2, 03,266 m^2 and mangrove as 53,250 m^2. The present study revealed total destruction of bivalve habitat in the dredging area. The existing mangrove coverage is about 13,479 m^2 (25.3%) area, which shows that 39,770 m^2 of mangrove habitat or 74.7% historic coverage is destroyed. This estuarine habitat loss is mainly due to the continuous dredging and reclamation activities in the area.



Impact of dredging on clam and mangrove habitats in Gurupur Estuary, Karnataka

The mangrove habitats along Mumbai which were affected by the oil spill in August 2011

Painting by Master Vaisakh. P.R., Government College of Fine Arts ,Thrissur which won the First Prize under the Senior category.

Students receiving the certificates from renowned artist Shri C.B. Shibu during the painting competition organized by CMFRI in a coastal village in Kerala

Restoration experiments at Kochi

Protocol for mangrove restoration (*Rhizophora mucronata)* was developed. It was found that soil plays a major role in the establishment of transplanted saplings of mangroves after the nursery stage.

Soil with less than 11% of clay was indicated as not suitable for transplantation for restoration of mangroves. Mangrove saplings grown in the nursery were distributed to one school in North Paravur and a college at Vaikom

Evaluation of early life history stages of fishes and shrimps in mangrove ecosystem

Mangroves are recognized as the nursery ground for several species of fishes and shellfishes. The Quantitative Seed Sampling unit developed by CMFRI was fabricated and used for a survey to estimate the quantity of seed / early life history stage of fishes. The Ichthyoplankton survey indicated the quantity of seed (nos. sqm^{-1}) of shrimp *(Fenneropenaeus indicus* : 22 to 162; *Metapenaeus dobsoni* 13 to 102; *M. affinis* 3 to 58); crab seed (4 to 8), finfish seed 5 to 287 mainly *Ambassis* sp., clupeids, gobiids, and carangids.

Effect of oil spill on mangrove at Mumbai

The cargo vessel MV Rak grounded on Mumbai coast causing oil spill along Juhu-Versova beach from Sunday 7th Aug. 2011onwards. About 100 metric tons of oil had been spilled into the sea. The field survey by MRC of CMFRI, Mumbai indicated impacts at Juhu, Versova Bandra and Mahim where patches of oil on the sand were observed. The cross section of the sea water that has been affected by the oil spill was 9 x 1 km. Mangroves of Bandra, Juhu in Greater Bombay district was found with oil smeared on them. On subsequent observation at Bandra bandstand on 17th August 2011, no traces of oil on mangrove areas were noticed.

Grazing pressure in the sea grass beds of selected coral atolls

Considerable decrease in the wet harvestable biomass (canopy) of seagrass beds in three atolls of Lakshadweep Archipelago occurred due to grazing pressure by turtles when compared to the values available 20 years ago which might affect the food chain and productivity of these atolls.

Wet harvestable biomass of seagrass from three atolls of Lakshadweep

Year of observation	Agati atoll	Kavarathi atoll	Kalpeni atoll
2011	112	116	420
1991 (Ansari *et al.*)	895	720	770

Generating awareness on marine environment: Painting competition

The Fishery Environment Management Division of CMFRI organized a painting competition for children aged between 5-20 years on 22nd March 2012 as a part of creating awareness in coastal communities on the importance of Coastal Environment Protection along with Elamkunnapuzha Grama Panchayat. Sixty nine students from more than 15 schools participated in the painting competition. Shri. C.B. Shibu, renowned artist distributed the participation certificates. The paintings by students of the senior category depicted the impact of non-biodegradable wastes in the fishing area and on the artisanal fishers.

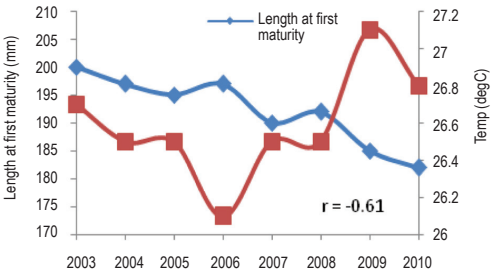
Climate Change

Marine fisheries

Extensive database has been established on time-series climatic parameters such as air temperature, wind speed and rainfall and oceanographic parameters such as seawater temperature, upwelling strength and chlorophyll for several lat-long positions along the Indian coast.

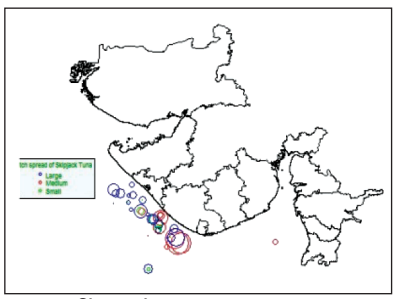
Several small pelagic populations are able to adapt by changing/extending their distributional ranges. Correlation of time series data of oceanographic and climatic parameters with fishery data shows that changing climatic and oceanographic features are favourable to small pelagic fish populations.

Phenological changes such as shift in spawning season, reduction in length at first maturity have been observed for species such as threadfin breams, oil sardine and Indian mackerel.



Length at first maturity of mackerel off Andhra Pradesh

Concentration and size composition of skipjack tuna changes between summer and winter seasons along Gujarat coast. Concentration during winter months is higher and closer to the coast, contributing to good fishery. This shows temperature related distribution, abundance and size composition of skipjack tuna.



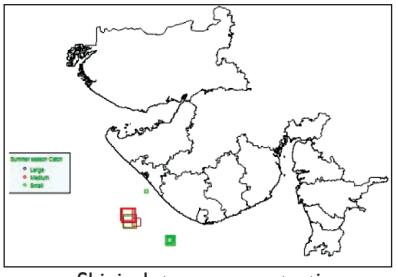
Skipjack tuna concentration during winter off Gujarat

Large amount of data on ITK and opinion of fishermen on climate change and marine fisheries have been collected and a compendium is under preparation.

Mariculture

A series of experiments were conducted to find out the impact of elevated seawater temperature on the ornamental fish, namely, the clownfish and food fishes, namely, cobia and pompano. Egg development, and larval growth were faster at elevated water temperature of 32-33 °C, but hatching success and larval survival were highest at ambient temperature of 29-30 °C.

Cell density of food of fish larvae, the microalgae T*etraselmis chuii* and *Isochrysis galbana* and the multiplication of copepod *Euterpina acutifrons* were highest at 29-30°C, and gradually reduced with increase in seawater temperature.



Skipjack tuna concentration during summer off Gujarat

Technology demonstration

The technology developed by CMFRI on cage culture of sea bass, cobia and pompano were demonstrated to fishermen and other stakeholders. Fabrication of low-cost cage and technique of all-weather mooring of cage were also demonstrated.

Impact, adaptation and vulnerability of Indian marine fisheries to climate change

Relationship between climatic & oceanographic parameters and fish catches

A canonical correlation analysis was carried out to find out the best possible linear combination of resources and climatic & oceanographic variables. As increase in fishing effort and efficiency has contributed significantly to increase in fish catches, the fishery development factors were phased out to decipher the impact of changing climatic factors. Application of interventional ARIMA model showed that these three interventions had a telling effect on the overall landing estimates of the resource (oil sardine). Hence this three variable exogenous ARIMA model can be treated as a working model to predict the time series and the residuals thereof can be subject to further analysis. This analysis has given the following valuable clues on the interaction between changing climatic & oceanographic variables and fish catches: (i) The correlation between resources and climatic variables are present in a masqueraded form; (ii) Major fishing practices have major influence on creating pseudo-correlation with climate variables; (iii) When the pseudo-correlations were removed, the deviations showed better cross-correlation trends. The influence of climatic parameters can be categorized into two based upon the canonical correlation, with coastal upwelling index and wind components being the most significant; (iv) Outlier analysis indicated that on three years, 1974, 1975 and 1994, there was a matching between the pelagic resource deviations and climatic extremities; (v) Future possibilities lie in modeling these residuals against the significant climatic parameters like coastal upwelling, SST and wind so that prediction based on climatic variables could be fine-tuned after adjusting for fishery based factors.

Vulnerability of coastal districts of Tamil Nadu

Vulnerability Index was calculated for 581 coastal villages in 13 coastal districts of Tamil Nadu. For this analysis, 15 sub-indicators under five indicators, namely, demography, infrastructure, occupation, climate variabilites and fisheries were selected. The functional relationship (positive or negative) between each sub-indicator and vulnerability level was identified and normalised so that they lie between 0 and 1. After normalisation, the average index (AI) for each sub-indicator was determined and the overall vulnerability index was computed. Among the coastal districts of Tamil Nadu, the Vulnerability Index was highest for Ramnathapuram (0.206) followed by Tirunelveli (0.175). The highest vulnerability of Ramanathapuram District was due to very high population density and poor literacy. In Tirunelveli District, the infrastructure facility was poor.

Strategies to enhance adaptive capacity to climate change in vulnerable regions

As a part of climate change adaptation measures, few technological interventions in selected villages have been made. One of that is 'm-KRISHI®-Fisheries mobile service' in partnership with TATA Consultancy Services, Innovation Lab by following Public Private Partnership (PPP) model to disseminate PFZ and wind advisories to fishers in local language. The service is operational in electricity shortage district of Raigad. While the project is looking after generating, editing and uploading PFZ advisories on m-KRISHI® Fisheries website after every 3-4 days, TCS Innovation Lab deals with generating, editing and uploading oceanic wind speed and direction advisories from INCOIS four times a day and regional wind speed and

direction advisories from IMD daily. TCS Innovation Lab is maintaining the server for the m-KRISHI® Fisheries website. Sixteen mobile handsets have been distributed to identified beneficiaries who can relay information to the community in selected villages. Daily updates are received by fishers on handsets through GPS technology. Together with community level coordinators, who have been trained to decode the diagrams and graphs, they update the notice board each morning. PFZ data were validated by undertaking cruises.

Carbon sequestration potential of Indian seaweeds

Carbon fixing efficiency and respiratory emission rate of the red alga *Kappaphycus alvarezii* and *Padina* sp. were studied. Among the two seaweeds, *Padina* sp. was found to fix higher levels of CO_2 (2 – 5 mg l^{-1}) than *K. alvarezii* (1 – 2 mg l^{-1}). Gross primary productivity and net primary productivity were higher in *Padina sp.* when compared to *K. alvarezii.* Highest CO_2 fixed by *K. alvarezii* was at dissolved CO_2 of 6 mg l^{-1} and that of *Padina* sp. was at 10 mg l^{-1} Seaweed farming on a large-scale, in suitable areas, would help to fix CO_2.

Socio- Economics

Resource management, economic sustainability and socio-economics

During 2011, the valuation of marine fish landings at the landing centre level (point of first sales) was estimated at ₹ 24,372 crores and that of the retail centres (point of last sales) was found to be ₹ 38,152 crores. The average fishermen share in the consumer's rupee was found to be 63.88 %.

The economic performance of various fishing methods across the maritime states was assessed and the salient findings are given below.

Mechanised sector

Single day operations

In BV Palem, Andhra Pradesh, the average operating cost per trip of the single day trawl fishing worked out to ₹ 8,572 per trip earning a gross revenue of ₹ 22,941 with a net operating income of ₹ 14,369 per trip. Fuel accounted for 57% of the total operating cost followed by crew wages 27%.

In Kakinada Fisheries Harbour, the average operating cost per trip of the single day trawl fishing worked out to ₹ 8,258 per trip earning a gross revenue of ₹ 21,238 with a net operating income of ₹ 12,980 per trip. Fuel accounted for 57% of the total operating cost followed by crew wages 25%.

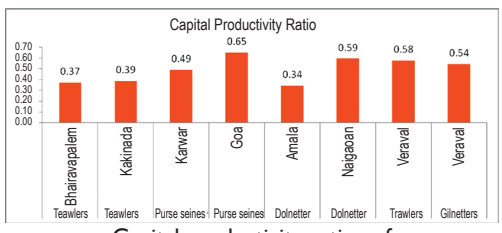
For a single day dolnetter operation in the Arnala landing centre of the coastal district of Thane, the average operating cost worked out to be ₹ 1453 per unit with an average gross return of ₹ 4342 during the post-monsoon.

For a single day dolnetter operation in the Arnala landing centre of the coastal district of Thane, the average operating cost worked out to be ₹1459 per unit with an average gross return of ₹ 4824 during the pre monsoon.

For a single day dolnetter operation in the Naigaon landing centre of the coastal district of Thane, the average operating cost worked out to be ₹ 1187 per unit with an average gross return of ₹ 2002 during the pre-monsoon.

For a single day trawl operation in Veraval landing centre in the coastal district of Junagadh, the average operating cost worked out to be ₹ 42,165 per unit with an average gross return of ₹ 73,125 during the post-monsoon.

For a single day trawl operation in Veraval landing centre in the coastal district of Junagadh, the average operating cost worked out to be ₹ 39,289 per unit with an average gross return of ₹ 72,412 during pre-monsoon.



Capital productivity ratios of single day operations

Multiday operations (2-5 days)

In BV Palem, the average operating cost per trip of the multi-day (2-5 day) trawl fishing worked out to ₹ 29,469 per trip earning a gross revenue of ₹ 65,386 with a net operating income of ₹ 35,917 per trip.

In Kakinada, the average operating cost per trip of the multi-day (2-5 day) trawl fishing worked out to ₹ 30,323 per trip earning a gross revenue of ₹ 74,881 with a net operating income of ₹ 44,489 per trip.

For a multiday trawl operation of less than 6 days in Veraval landing centre in the coastal district of Junagadh, the average operating cost worked out to be ₹ 211576 per unit with an average gross return of ₹ 372865 during the pre-monsoon

For a multiday dolnetter operation of 2-5 days in the Naigaon landing centre of the coastal district of Thane, the average operating cost worked out to be ₹ 74415 per unit with an average gross return of ₹ 113726 during the pre-monsoon.

For a multiday dolnetter operation of 2-5 days in the Naigaon landing centre of the coastal district of Thane, the average operating cost worked out to be ₹ 131527 per unit with an average gross return of ₹ 306523 during the post-monsoon.

For multiday gillnet operation landing centre of Satpati in the coastal district of Thane, the average operating cost worked out to be ₹ 66416 per unit with an average gross return of ₹ 96739 during the pre-monsoon.

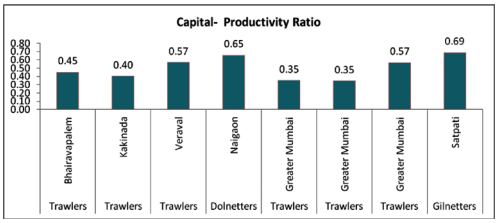
For a multiday gillnet operation landing centre of Satpati in the coastal district of Thane, the average operating cost worked out to be ₹ 70629.50 per unit with an average gross return of
₹ 232079.50 during the post-monsoon.

For multiday purse seines operations of 2-5 days in the landing centre of Mirkarwada in the coastal district of Ratnagiri, the average operating cost worked out to be ₹ 17681.33 per unit with an average gross return of ₹ 56591.67.

For a multiday trawl operation of 2-5 days in New Ferry Wharf landing centre in the coastal district of Greater Mumbai, the average operating cost worked out to be ₹ 70919 per unit with an average gross return of ₹ 200317 during the post-monsoon

For multiday trawl operation of 2-5 days in Sasoon Docks landing centre in the coastal district of Greater Mumbai, the average operating cost worked out to be ₹ 37207 per unit with an average gross return of ₹ 107422 during post-monsoon

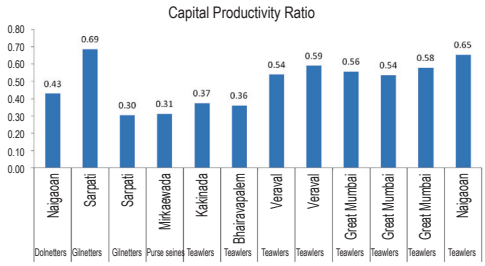
For multiday trawl operation of 2-5 days in Versova landing centre in the coastal district of Greater Mumbai, the average operating cost worked out to be ₹ 63358 per unit with an average gross return of ₹ 112090 during the post-monsoon



Capital productivity ratios of multiday operations (2-5 days)

Multiday operations (More than 6 days)

In Kakinada Fisheries Harbour (KFH), the average operating cost per trip of the multiday (6-8 days) trawl fishing worked out to ₹ 56,333 per trip earning a gross revenue of ₹ 1,50,813 with a net operating income of ₹ 94,880 per trip. Fuel accounted for 54% of the total operating cost followed by crew wages 27 %.



Capital productivity ratios of multiday operations (more than 6 days)

In BV Palem, the average operating cost per trip of the multiday (6-8 days) trawl fishing worked out to ₹ 52,064 per trip earning a gross revenue of ₹ 1,44,201 with a net operating income of ₹ 92,137 per trip. Fuel accounted for 56% of the total operating cost followed by crew wages 28%.

For a multiday trawl operation of more than 6 days in Veraval landing centre in the coastal district of Junagadh, the average operating cost worked out to be ₹ 472356.00 per unit with an average gross return of ₹ 876,125.00 during the post-monsoon.

For a multiday trawl operation of more than 6 days in Veraval landing centre in the coastal district of Junagadh, the average operating cost worked out to be ₹ 471792 per unit with an average gross return of ₹ 799487 during the pre-monsoon.

For a multiday trawl operation of more than 6 days in New Ferry Wharf landing centre in the coastal district of Greater Mumbai, the average operating cost worked out to be ₹ 103719 per unit with an average gross return of ₹ 186215 during the post-monsoon.

For a multiday trawl operation of more than 6 days in Versova landing centre in the coastal district of Greater Mumbai, the average operating cost worked out to be ₹ 83368 per unit with an average gross return of ₹ 144173 during the post-monsoon.

For a multiday trawl operation of more than 6 days in Naigaon landing centre in the coastal district of Thane, the average operating cost worked out to be ₹ 93518 per unit with an average gross return of ₹ 143254 during the post-monsoon.

Among the multiday trawl operation for more than six days the capital productivity ratio of trawlers operating in Naigaon was found to be the highest followed by Versova, Sasson Doc and New Ferry Wharf during the post-monsoon.

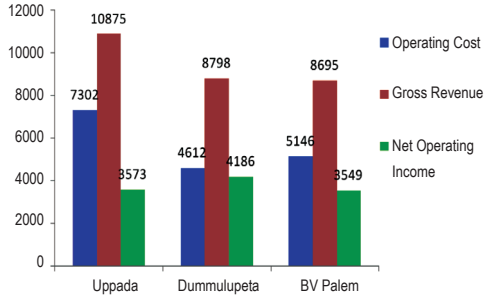
For a multiday trawl operation of more than 6 days in Sasson doc landing centre in the coastal district of Greater Mumbai, the average operating cost worked out to be ₹ 97433 per unit with an average gross return of ₹ 181780 during the post-monsoon.

Motorised fishing

In BV Palem, the average operating cost per trip of the single day motorized fishing operating gill net worked out to ₹ 5,146 per trip earning a gross revenue of ₹ 8,965 with a net operating income of ₹ 3,549 per trip. The capital productivity was 0.57. Crew wages accounted for a higher share of 50% in the total operating cost than the fuel cost, which shared 36% of the operating cost.

In Dummulupetta, the average operating cost per trip of the single day motorized fishing operating gill net worked out to ₹ 4,612 per trip earning a gross revenue of ₹ 8,798 with a net operating income of ₹ 4,186 per trip. The capital productivity was 0.52. Crew wages accounted for a higher share of 47% in the total operating cost than the fuel cost, which shared 44% of the operating cost.

In Uppada, the average operating cost per trip of the single day motorized fishing operating gill net worked out to ₹ 7,032 per trip earning a gross revenue of ₹10,875 with a net operating income of ₹ 3,843 per trip. The capital productivity was 0.65. Crew wages accounted for a higher share of 80% in the total operating cost than the fuel cost, which shared 19% of the operating cost.



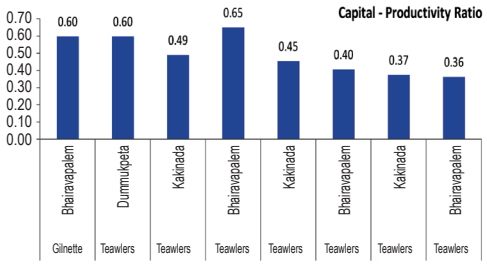
Economic performance of motorised fishing in Andhra Pradesh

In Dummulupetta, the average operating cost per trip of the two-day motorized fishing operating gill net worked out to ₹ 8,992 per trip earning a gross revenue of ₹ 17,695 with a net operating income of ₹ 8,703 per trip. The capital productivity was 0.51. Crew wages accounted for a higher share of 48% in the total operating cost than the fuel cost, which shared 44% of the operating cost.

Non-mechanised sector

In BV Palem, the average operating cost per trip of the single day non-mechanised fishing operating gill net worked out to ₹ 1,292 per trip earning a gross revenue of ₹ 2,171 with a net operating income of ₹ 879 per trip.

In Dummulupetta the average operating cost per trip of the single day non-mechanised fishing operating trawl net worked out to ₹ 848 per trip earning a gross revenue of ₹ 1,424 with a net operating income of ₹ 576 per trip. Crew wages accounted for 68% of the total cost.



Capital productivity ratios of non-mechanised sector

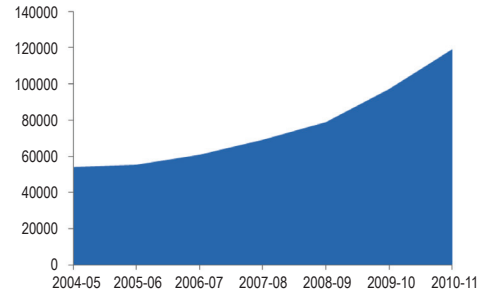
Total factor productivity analysis

The total factor productivity growth in marine fisheries in India was worked out for the period 2000- 2010 using the quantities and shares of labour and fuel as input variables and the quantities and shares in the total revenue of 12 resource groups. The output index showed a positive growth of 3.4% during the period 2000-10.

Analysis of shares of different resources in the gross revenue earned during the period 2000 to 2010 showed that share of crustacean sin the gross revenue increased from 38.68% in 2000 to 40.69% in 2010. The share of clupeids declined from 11.44% in 2000 to 10.80% in 2010. The share of cephalopods increased from 6.53% to 9.77% and the share of seer fishes declined from 5.6% to 4.25%. The share of mackerels, carangids, pomfrets and other pelagics remained the same during 2000-10 period.

Fuel consumption in the marine fishing sector

The annual diesel consumption in Kerala has shown a continuous increase over the years with multiday fishing operations and use of Chinese engines with very high capacity (up to 440 hp) and high diesel consumption. The diesel consumption increased from 54 million litres in 2004-05 to 119 million liters in 2010-11.



Growth in diesel consumption in Kerala

Labour use in the marine fishing sector

The labour employed in the marine fishing sector was almost stagnant at 100 million days. In the mechanised sector the labour days increased from 57.31 mn in 2000 to 81.48 mn in 2009 and then declined to 71.71 million days in 2010. The labour employed in the motorised sector declined from 25.62 million days to 22.95 million days and in the non-mechanised sector the labour employed drastically reduced from 11.95 million days to 4.59 million days.

State wise total factor productivity index

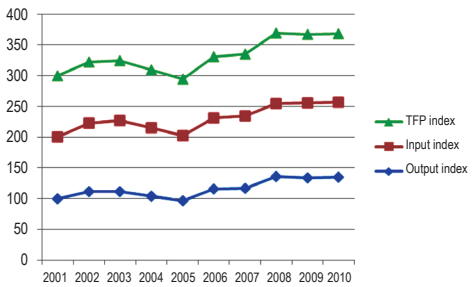
The state wise analysis of total factor productivity growth showed that the TFP growth was positive in the east coast (8.16%), whereas it was negative in the west coast (-0.17%) during 2000-10 period. The total factor productivity growth was highest in Odisha with increased landings of high value resources like shrimps and increased efficiency with mechanised fishing.

State wise total factor productivity growth (2000-10)

States	TFP growth
West Bengal	6.42
Odisha	18.06
Andhra Pradesh	5.80
Tamil Nadu	4.18
Puducherry	13.75
East coast	**8.16**
Kerala	-3.69
Karnataka	2.88
Goa	4.52
Maharashtra	-5.83
Gujarat	3.15
West coast	**-0.17**

Labour days in the marine fishing sector in India (in million days)

Years	Mechanised	Motorised	Non-mechanised	Total
2000	57.31	25.62	11.95	94.88
2001	57.69	25.70	11.19	94.57
2002	67.34	27.33	10.43	105.10
2003	69.96	28.14	12.36	110.46
2004	66.36	26.67	11.65	104.68
2005	68.68	22.36	9.03	100.07
2006	75.60	25.14	8.58	109.32
2007	74.38	26.89	7.84	109.11
2008	78.99	27.04	6.18	112.21
2009	81.48	25.08	6.07	112.63
2010	71.71	22.95	4.59	99.25



Growth in input, output and TFP indices

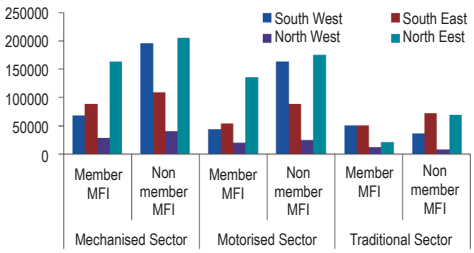
The negative total factor productivity growth in the west coast was due to the negative output index growth rates in the major producing states of Kerala and Maharashtra. The reduction in the landings of the high value resources like shrimps in these states in the past decade might have contributed to the negative output index growth rates.

At all India level the input index showed a positive growth of 1.7% and the total factor productivity growth showed a positive growth of 1.7%. The positive total factor productivity growth showed the economic sustainability of the production system.

Fisheries governance, livelihood, gender and welfare

Poverty and Indebtedness

The poverty is measured using a methodology proposed by Alkire and Foster (2007, 2009) known as Multidimensional Poverty Index (MPI). Using three dimensions: health, education, and standard of living and ten parameters namely year of schooling, child enrollment, child mortality, nutrition, electricity, drinking water, sanitation, flooring, cooking fuel and assets. A household is identified as multidimensional poor if and only if it is deprived in some combination of indicators whose weighted sum exceeds 30% of all deprivations. The multi-dimensional poverty index of Ramanathapuram district of Tamil Nadu revealed that 31.1% of marine fisher folk were multidimensional poor. Indicator-wise analysis revealed that majority were deprived of drinking water and sanitation facilities.



Level of indebtedness across the different coastal states in India (Rs.)

The indebtedness level of fishers based on the involvement as a member/ non member in the micro finance institutions of the different fishing zones were assessed and it was found that the indebtedness level was lower with fishers involved as members in the micro finance institutions.

The level of repayment of loans were analyzed among the selected household are indicated below.

In Ramanathapuram district of Tamil Nadu 26% of SHGs were able to repay 81-100% of the loan which they borrowed. It is interesting to note that 39% of marine fisherfolk population were indebted to fish traders followed by 37% in banks. Majority of the respondents ranked first for the following attributes with respect to MFI functioning were: easy approval process, diverse areas of funding, provision of longer loans, provision of loan grace periods and easy repayment schedule.

Level of repayment of loans across the different sector

% of Repayment of loans						
	Mechanised sector		Motorised sector		Traditional sector	
Zone	Member MFI	Non-member MFI	Member MFI	Non-member MFI	Member MFI	Non-member MFI
South-west	14.10	26.75	40.52	22.60	32	14
South-east	25	19.60	27.50	26	20	24.50
North-west	10	12	8	8	12	6
North-east	25	23	28	26	22	13.50

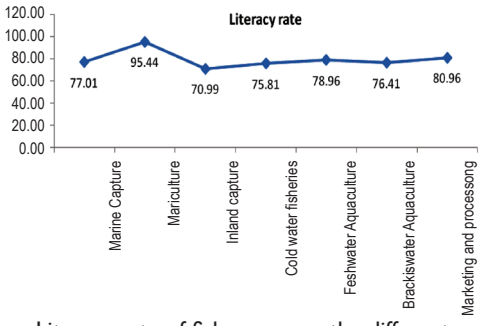
Awareness campaign on micro finance

Literacy, health and income of fishers in India

The status of literacy, health and income of the marine and inland fishers, fish farmers and workers in the allied activities in both capture and culture system were assessed.

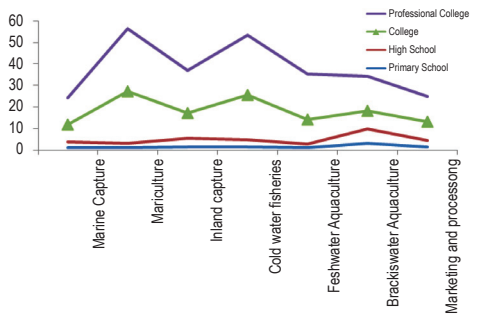
The general literacy rate of India as a whole was 73.52% (Census 2001) against the literacy rate of 64.64% among the fisherfolk. The results indicated that among the literates 32.85% had primary level of education, 53.88% had secondary level of education and 13.10% had collegiate level of education. The overall literacy rate for the total samples was found to be 79.37% which is higher than the national literacy level of 74.04% (Census 2011)

The literacy rate ranged from 70.99% in inland capture sector to 95.44% in mariculture. The results indicated that literacy does not seem to be skewed towards any particular sector among fisher population.



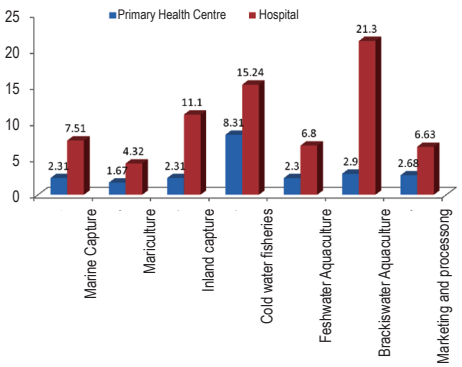
Literacy rate of fishers across the different sectors

The access to education was analyzed by finding the distance to the nearby educational institutions. The average distance from fishing villages to nearly primary, high school, college and professional institution is represented in the figure. The average distance to a primary school is 1.46 km, high school 3.40 km college 13.33 km and professional institution 19.48 km from fishing villages in India. The average distance to primary school ranged from 0.90 km in freshwater aquaculture to 3.23 km for brackishwater aquaculture. The average distance to high school ranged from 1.90 km in freshwater aquaculture to 6.67 km for brackishwater aquaculture. The average distance to colleges ranged from 8 km in marine capture to 24.24 km for mariculture sector. The average distance to professional colleges ranged from 11.90 km in marketing and processing sector to 29.04 km for mariculture. The results indicated that the improved or increased access to educational facilities has helped to increase the literacy level of the fisherfolk.



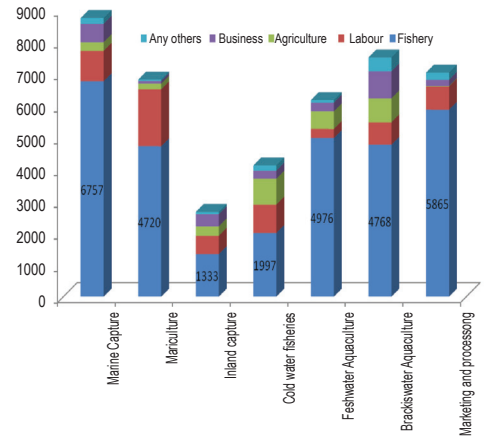
Access to education of fishers across the different sectors (km)

The access to health care is also an important parameter which determines the continued health of the fisherfolk. Often the distance leads to the non-treatment or its delay. The access to health care was measured using the distance required to avail the same. The results indicated that there exists considerable access to the primary health centre and hospital. The access to primary health centre ranged from 1.67 km in the mariculture sector to 8.31 km in the case of cold water fisheries. The access to hospitals ranged from 4.32 km in the mariculture sector to 21.3 km in the case of brackishwater fisheries.

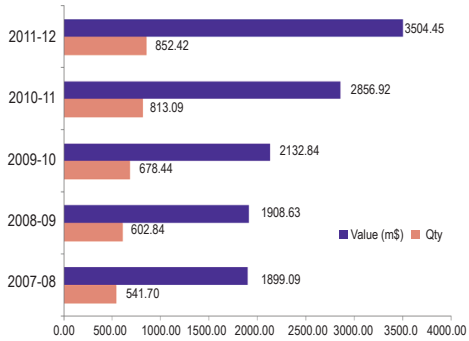


Access to health care facilities for fishers across the different sectors (km)

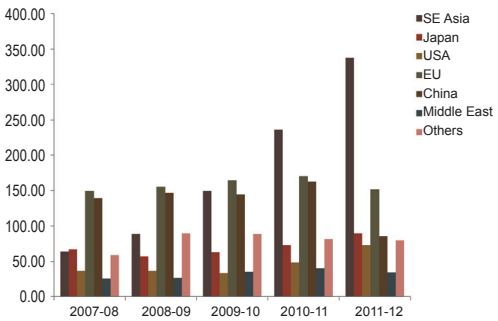
The major income sources of the respondent households comprised of income from fishery, business, agriculture, labour services, and other service sectors. The highest average monthly income was noticed in marine capture sector at ₹ 8742 and the least was noticed in inland capture sector.



Average monthly income details of fishers across the different sectors



Fisheries exports over the years post-recession



Geographic concentration of exports (post-recession) quantity terms

The fisheries monthly average income was most for marine capture fisheries sector followed by marketing and processing and the least for inland capture. Labour monthly average income was most for mariculture (₹ 1785) and the least for freshwater aquaculture (₹ 287). Agricultural monthly average income was most for cold water fisheries (₹ 812) and least for marketing and processing sector (₹ 17)

Markets, trade and environment

Domestic marketing

The marketing efficiency analysis of fish marketing across the landing centre, wholesalers and retailers indicated that the market dynamics had improved from the traditional huge price spread for high value fishes and low price spread for low value fishes. The results indicated that the price spread is in dependent of the value of the fish but mostly dependent on size and quality.

The marketing efficiency analysis of fish marketing in selected markets of Maharashtra indicated that the price spread varied across the species and its size. In the case of small size the producers share of the consumers rupee was highest for rock cods (86.38%) followed by pomfrets (80.21%), penaeid prawn (79.28%) and catfishes (76.28%) and lowest for local penaeid prawn (38.25%), other clupeids (48.32%), cephalopods other than *Sepia* (47.29%), rays (51.28%) and sharks (55.81%).

In the case of medium sized species the threadfin breams, catfishes, ribbonfishes and pomfrets registered a higher producer's share of consumers rupee whereas the penaeid prawns, goatfishes and eels had a huge price spread.

The results on the marketing efficiency of large sized fish species indicated that pomfrets, mackerels, carangids and penaeid prawns registered an average producers share of 75.62% whereas the ribbonfishes, oil sardine, sharks and rays registered a lower average producers share of 62.45% of the consumers rupee.

In Karwar the average price of marine fish species varied from ₹ 11/kg for silverbellies and oil sardines to ₹ 182/kg for penaeid prawns at landing centre level. At retail level the average price varied from ₹ 27/kg for silverbellies, ₹ 40/kg for oilsardines, ₹ 43/kg for lizard fishes to ₹ 265/kg for silver pomfret, ₹ 265 /kg for penaeid prawns. The maximum price spread was for silver pomfret at ₹ 169/kg and the lowest was for silverbellies at ₹ 16/kg. Fishermen's share in the consumer's rupee varied from 24% for anchovies and other clupeids to 82% for black pomfret.

In Goa landing centres the lowest price was recorded for silverbellies, snappers and ribbon fishes (₹ 30/kg) and the highest for penaeid prawns at ₹ 199/kg. At retail level, the lowest price was recorded for oil sardines at ₹ 38/kg and the highest for silver pomfrets at ₹ 417/kg. The highest price spread was recorded for snappers at ₹ 216/kg followed by seerfishes (*S.commersoni*) at ₹ 129/kg and the lowest spread was recorded for goatfishes at ₹ 11/kg. Fishermen's share in the consumer's rupee varied from 12.21% for snappers to 80.66% for penaeid prawns.

The tradeoff between the domestic process and the international process of high value species like shrimps, cephalopods, pomfrets and seerfish were worked out. It was found that even though the domestic prices were on an average 20-25% more than the export prices, due to the export economies of scale the export flow continues to be on the higher side.

International trade

Despite the effects of recession, Indian foreign exchange earnings from fish exports continued to surge up new heights. The exports are expected to cross the 3.5 billion dollar mark with a million tonne of export during 2012-13. The global competitiveness of Indian seafood exports was analyzed and it was found that the recession hasn't created any bottlenecks in the exports. Recession has created an opportunity by way of increased exports across to the major buyer countries. The reason for the sustained increase in export is due to the demand for raw fish rather than value added products from the retail outlets as the buyers opted for cheaper fish on account of lower income, purchasing power and increasing unemployment.

The introduction of the exotic species *i.e.,* Pacific white shrimp, *Litopenaeus vannamei* in the culture system added to the increased exports from India. *L. vannamei* is a preferred shrimp species in the European market recording better returns with a per hectare production of 20 tonnes/ ha when compared to 2-3 tonnes/has for black tiger shrimp. The culture duration is 3 months as compared to 5 months for tiger shrimps .

Anti-dumping duty had a major impact on shrimp exports to the US which plummeted from $409 million in 2003 before the duty imposition to $142 million in 2008. But the recent notification on Zeroing methodology for imports by the International Trade Administration coming under the US Department of Commerce will ensure that the evasion of anti-dumping duty for Indian shrimp exports.

The analysis of the short run and long run gains on the SPS and compliance measures by the exporter's analysis indicated that with the huge cost of investment required for the compliance of EU approval and HACCP implementation the gains weren't significant due to non-capacity utilization of the processing plant and lack of raw materials. The processing plants which have implemented the compliance investment for the EU approval are yet to break even their cost of investment even after 8 -10 years on account of processing capacity utilization to the tune of 22-25%.

Though exports bring in valuable earnings, the diversification of fish and fishery products from local communities may lead to food insecurity. Thus there exists a question of availability and affordability of high value fishes in domestic market. The tradeoff between export and domestic trade was investigated by consumption studies across urban consumers in Calicut, Chennai and Mumbai. The results indicated that there exists considerable willingness to pay for the high value fishes

Fuel subsidies, preferential tax treatments, boat construction subsidies comes under the WTO definition of subsidies set forth in WTO agreement on subsidies and countervailing measures. In India the different types of subsidies include, subsidies to marine fisheries development (motorization of crafts and reimbursement of excise duty or sales tax exemption on fuel, subsidies for kerosene, construction of fishing harbours and other infrastructure, support for domestic marketing, processing facilities, subsidies for promotion of aquaculture, subsidies for different institutions for research and development, and export subsidies). Among the different items, subsidies to marine fisheries development infrastructure and post-harvest operations and export subsidies are considered as harmful subsidies.

The various fishery development measures like motorization of crafts and rebate on HSD oil and fishing harbor development are included under the subsidy class of WTO as they directly promote fishing operations.

Export subsidies (2010-11)

Export subsidies	Amount (₹ lakhs)
Tuna longlining	100.00
Development of potential farming area	679
Organic aquaculture	14.19
Digital data base on aquafarms	37.00
Ornamental fish breeding	209.00
Subsidy for promotion of aquaculture	414.00
Acquisition of processing machinery	1200.00
Technology for upgradation of marine products	105.00
Basic facilities for chilled fish/tuna	148.00
Effluent treatment plant	18.00
Promotion of aquaculture societies	177.00
Labs for quality certification	21.33
Landing centres/ fishing harbours, ice making machines, chill rooms	300.00
PCR lab	40.68
Total	**3463.20**

Subsidies in the marine fisheries sector in India (2010-11)

Items	Amount (₹ lakhs)
Marine fisheries development	
a) Motorization of traditional crafts (central share 50% state share 50%)	498.00
b) Rebate on High Speed Diesel (HSD) (central share 80% state share 20%)	936.00
Establishment of fishing harbours and other infrastructure	**5282.00**
Welfare measures	**746.00**
Institutes	**4376.00**
NFDB	**8675.00**
Aquaculture	**2000.00**
Total	**22,513.00**

Growth in subsidies in marine fisheries development, infrastructure and post-harvest operations

The assistance for fishing harbor development is considered as an indirect subsidy in the WTO definition. NFDB also promotes fisheries through development of fishing harbours, assistance to fish markets and deep sea fishing. The total assistance for marine fisheries development was ₹ 998 lakhs in 2010-11. The support to institutes like fishery survey of India, Central Institute of Fisheries Nautical Engineering Training (CIFNET), NIFPHAT and Central Coastal Engineering Institute, are considered favorable as they promote sustainable fishing practices. Export subsidies are provided through various export promotion schemes of MPEDA. The total export subsidies amounted to ₹ 3463.20 lakhs in 2010-11.

The expenditure on subsidies for marine fisheries development, infrastructure and post-harvest operations declined from ₹ 60.85 crores in 2005-06 to ₹ 41.49 crores in 2007-08 and then increased to ₹ 62.8 crores in 2010-11. The total amount of subsidies to fisheries sector is ₹ 259 crores only which is less than one per cent of the fisheries GDP in India.

CMFRI hosted 9th Indian Fisheries Forum at Chennai

The five-day national triennial conference with the theme "Renaissance in fisheries-Outlook and Strategies" was attended by more than 1000 fisheries experts from various research institutes, universities, fisheries-related industries, and NGOs across the country.

Dr. M.V. Gupta, the World Food Prize Winner inaugurated the 9th Indian Fisheries Forum hosted by Central Marine Fisheries Research Institute (CMFRI) in association with the Asian Fisheries Society (AFS) at the IMAGE auditorium on 19th December 2011 at Chennai. He outlined a twin-track strategy for bringing about renaissance in Indian fisheries sector by focusing on sustainable intensification of aquaculture and implementing a scientifically informed governance system in the capture fisheries sector. He pointed out that the government should pay more attention in making the State level delivery mechanisms more efficient.

An exhibition showcasing the recent technological and entrepreneurial developments in the Fisheries Sector was also organized during the conference.

The abstract book and the 9th IFF souvenir were released on the occasion.

Nearly 550 delegates registered for the forum and more than 672 abstracts were received for the presentations (443 Oral and 229 Poster).The presentations were grouped under following themes: Fisheries Resources Management (FR), Aquaculture Production (AP),Genetics, Breeding and Biotechnology (GB), Environmental Impacts and Aquatic Health (EH), Nutrition and Fish Health (NH),Harvest and Post-harvest technology (HP), Socio-economics, Marketing and Livelihood (SE),Fish and Fish Related Biodiversity (BD),Climate Change and Natural Disaster Management (CC),and Fisheries Trade, Policies and Governance (FT).

Dr. M.V. Gupta, the World Food Prize winner inaugurating the 9th Indian Fisheries Forum by lighting the lamp

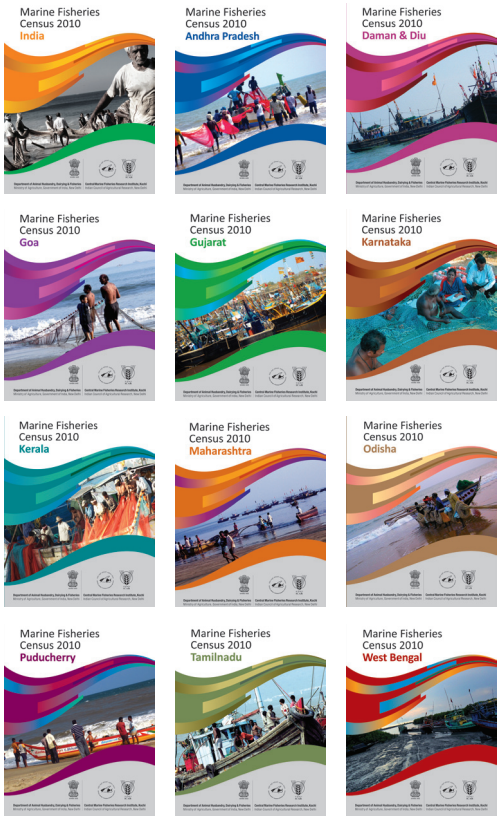
Inaugural address by Dr. M.V. Gupta


A section of the delegates

Dr. G. Syda Rao, Convener, 9th IFF and Director, CMFRI, delivering vote of thanks

Marine Fisheries Census 2010

Dr. S. Ayyappan, Director General, ICAR releasing the report of Marine Fisheries Census 2010



The Marine Fisheries Census 2010 reports were released by Dr. S. Ayyappan, DG, ICAR on 5th May, 2012 at CIFT, Cochin. The report consists of Part-I All India and Part-II in eleven volumes for nine maritime states and Union Territories of Puducherry and Damen & Diu.

There are 3,288 marine fishing villages and 1511 marine fish landing centres in 9 maritime states and union territories. The total marine fishermen population is about 4.0 million comprising in 8,64,550 families. Nearly 61% of the fishermen families are under BPL category. The average family size is 4.63 and the overall sex ratio is 928 females per 1000 males. Almost 58% of the fisherfolk are educated with different levels of education. About 38% marine fisherfolk are engaged in active fishing with 85% of them having full time engagement. About 63.6% of the fisherfolk are engaged in fishing and allied activities. Nearly 57% of the fisherfolk engaged in fish seed collection are females and 43% are males. Among the marine fishermen households nearly 76% are Hindus, 15% are Christians and 9% are Muslims. The overall percentage of SC/ST among the marine fishermen households is 17%. Nearly 32% of the adult fisherfolk have memberships in co-operatives. Among the marine fishermen households 1,31,012 families are having life saving equipments. In the marine fisheries sector there are 1,94,490 crafts in the fishery out of which 37% are mechanized, 37% are motorized and 26% are non-motorized.

Out of a total of 1,67,957 crafts fully owned by fisherfolk 53% are non-motorized, 24% are motorized and 23% are mechanized. Among the mechanized crafts fully owned by fishermen 29% are trawlers, 43% are gillneters and 19% are dolnetters.

Major Events

Dr S. Ayyappan, Secretary, DARE and Director General, ICAR launched the open access online Indian Journal of Fisheries in the ICAR website at a function held at Visakhapatnam RC of CMFRI.on 10-6-2012.

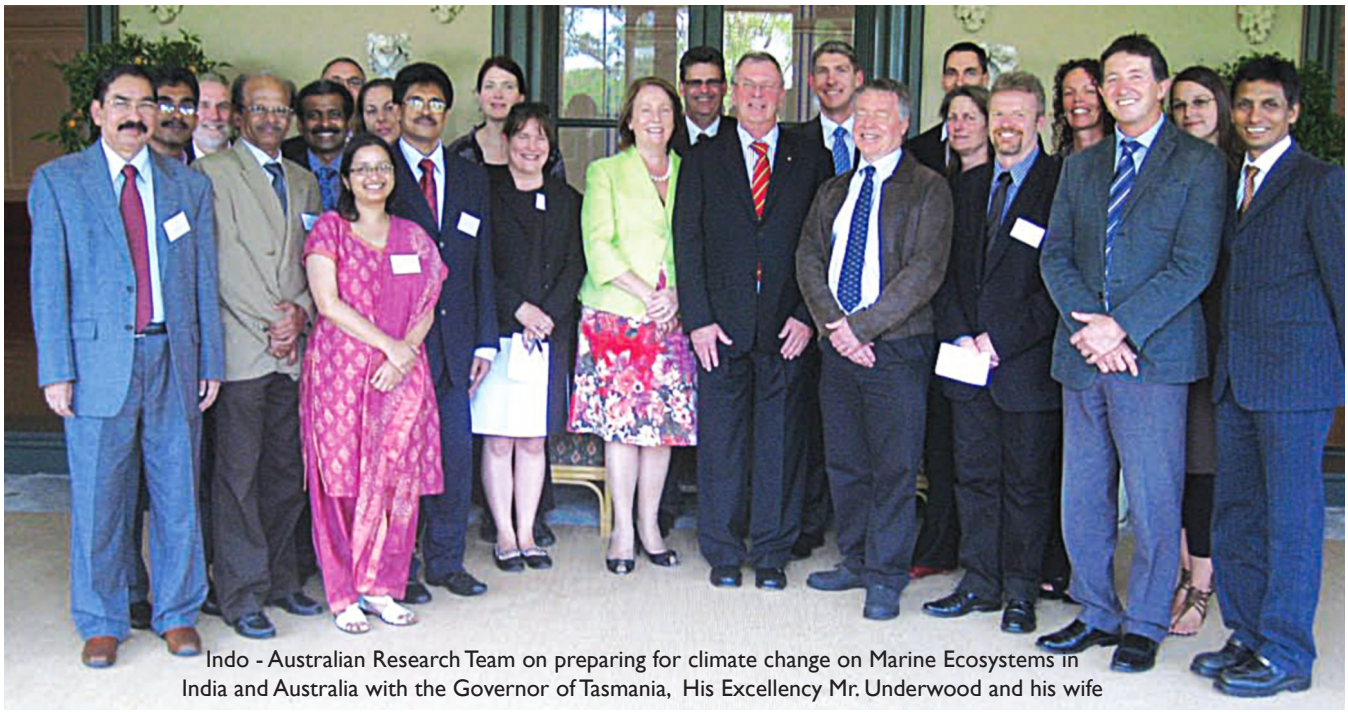
The Director General has dedicated the mariculture laboratories of Visakhapatnam Regional Centre of CMFRI that played a significant role in development of technologies for commercially important species, to the Nation on 10-6-2012.

An International Training Course termed as Regional Training Course on "Strengthening Fisheries Data Collection and Stock Assessment" was jointly organized by CMFRI and Fishery Survey of India at Cochin from 25th April to 7th May 2011.

International Workshops on

"Preparing for climate change on Marine Ecosystems in India and Australia"

Hobart, Australia, 16 - 20 January 2012 & Kochi, India, 6 -10 March 2012



Indo - Australian Research Team on preparing for climate change on Marine Ecosystems in India and Australia with the Governor of Tasmania, His Excellency Mr. Underwood and his wife

First Workshop conducted at Hobart, Australia (16-20 January 2012)

Under the Australia-India Strategic Research Fund (AISRF) project the first International Workshop on Preparing for Climate Change on the marine systems in India and Australia for building a Draft Strategic Collaborative Research Plan was organized in Hobart, Tasmania (Australia) during 16-20 January 2012.

The Indian team was lead by Dr. G. Syda Rao, Director, CMFRI and the Australian team by Dr. Stewart Frusher, Program Leader: Estuaries and Coasts, Institute of Marine and Antarctic Studies, University of Tasmania.

Second Workshop conducted at CMFRI, Kochi (6-10 March 2012)

The International Workshop on "Preparing for Climate Change on Marine Systems in Australia and India" was held at CMFRI, Cochin during 6-10 March 2012. The workshop was inaugurated by Mr. Michael Carter, His Excellency, the Consul Commercial and Trade Commissioner of Australia at Chennai.

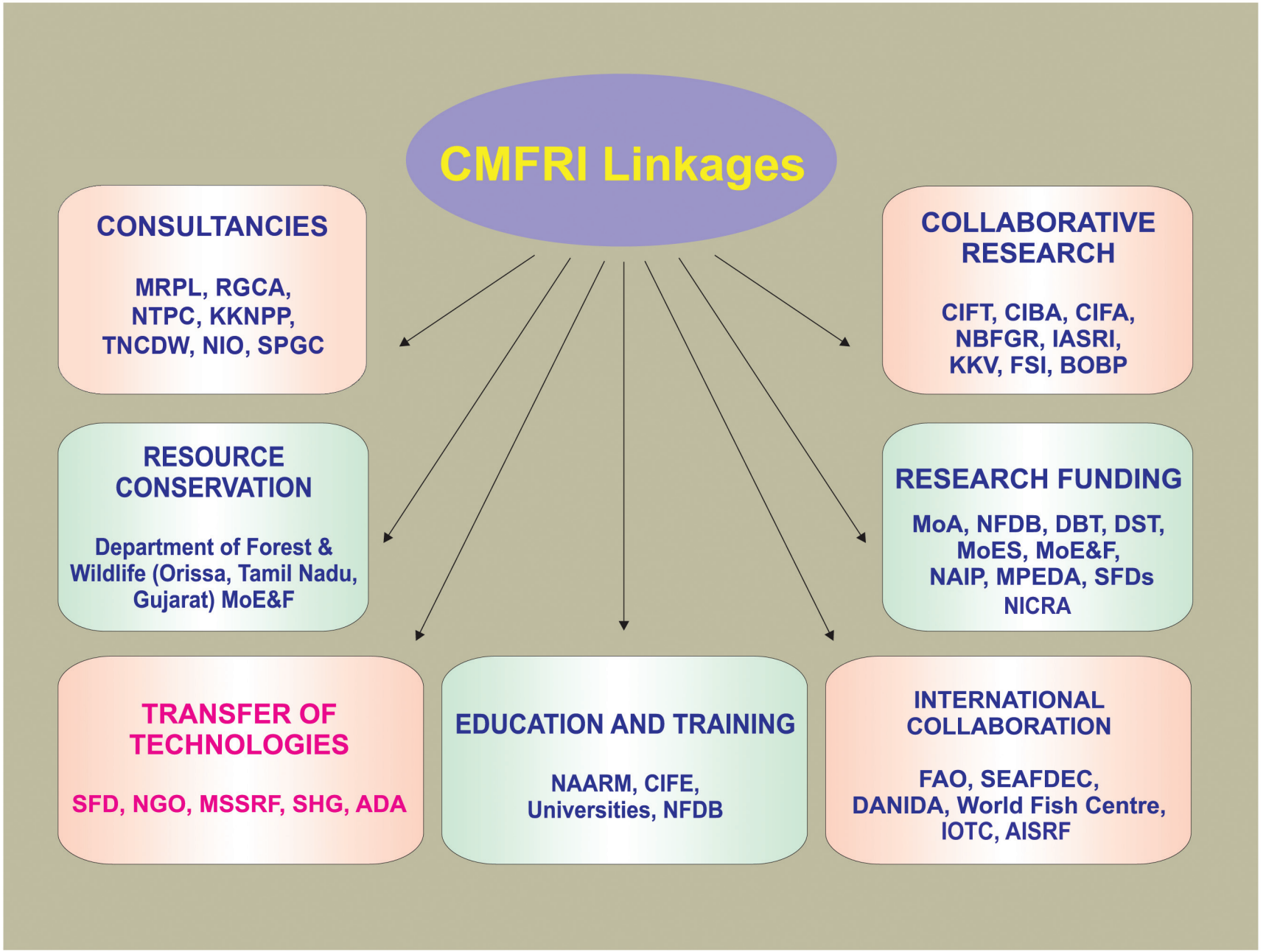
One day international seminar on "Emerging issues in Asian Aquaculture" was held at CMFRI on 12th May 2011. The seminar was organized jointly by CMFRI and NACA (Network of Aquaculture Centers in Asia -Pacific, intergovernmental organization promotes rural development through sustainable aquaculture), in continuation with the 22nd NACA Governing Council Meeting in Cochin, during 9-11thMay, hosted by Government of India.

Honb'le Chief Minister of Kerala Shri. Oommen Chandy unveiled the foundation stone for the proposed office cum Laboratory Complex of Vizhinjam Research Centre on 3-9-2011 Dr. Shashi Tharoor, MP, Smt. Jameela Prakasam, MLA, Dr. S. Ayyappan, Director General, ICAR and Dr. Meenakumari, DDG (Fisheries) attended the function.

Dr. Charan Das Mahant, Hon'ble Minister of State for Agriculture and Food Processing Industries, Govt. of India releasing CMFRI's CadalminTM Green Algal extract at New Delhi

CMFRI's CadalminTM Green Algal extract (GAe) has been released at 83rd Annual General Meeting of the ICAR Society at National Agricultural Science Complex by Dr. Charan Das Mahant, Hon'ble Minister of State for Agriculture and Food Processing Industries, Govt. of India on 6.03.2012. Shri Sharad Pawar, Hon'ble Union Minister of Agriculture and Food Processing Industries and President of the ICAR Society presided over the function. Earlier, Dr. S. Ayyappan, Hon'ble Secretary, DARE and Director General, ICAR presented a glimpse of key achievements of ICAR during 2011-12. Agriculture and Animal husbandry Ministers of various States, Members of the Governing Body of the ICAR and representatives from international organizations participated in the AGM along with senior ICAR officials of ICAR and other dignitaries. Concurrently, an exhibition on agri-technologies is also organized on the theme "Innovative Technologies go Commercial" in which CMFRI product Cadalmin Green Algal Extract (GAe) has been exhibited as ICAR technology.

The new Marine Hatchery-cum-Research Complex at Kovalam Field Laboratory of CMFRI, Chennai, was inaugurated by Dr. S. Ayyappan, Secretary, DARE and DG, ICAR on 3rd March 2012, in the presence of Dr. B. Meenakumari, DDG (Fy), ICAR Dr. G. Syda Rao, Director, CMFRI.


CMFRI Linkages
CONSULTANCIES
MRPL, RGCA, NTPC, KKNPP, TNCDW, NIO, SPGC
COLLABORATIVE RESEARCH
CIFT, CIBA, CIFA, NBFGR, IASRI, KKV, FSI, BOBP
RESOURCE CONSERVATION
Department of Forest & Wildlife (Orissa, Tamil Nadu, Gujarat) MoE&F
RESEARCH FUNDING
MoA, NFDB, DBT, DST, MoES, MoE&F, NAIP, MPEDA, SFDs NICRA
TRANSFER OF TECHNOLOGIES
SFD, NGO, MSSRF, SHG, ADA
EDUCATION AND TRAINING
NAARM, CIFE, Universities, NFDB
INTERNATIONAL COLLABORATION
FAO, SEAFDEC, DANIDA, World Fish Centre, IOTC, AISRF

Patents and ITMU

The following patents have been either submitted for complete application in the patent office (Chennai) and/or requested for examination:

Information regarding Patents, TradeMark, Copyright, Design during 2011-2012

Date of filing application		Application number	Title	Status of application (Disposed of/Pending)
Provisional: 20/7/2010	Complete: 6/4/2011	2065/CHE/2010	A process to concentrate anti-inflammatory principles from green mussel *Perna viridis* L. and a product incorporating these ingredients	Examination request filed (27/9/11)
Provisional: 20/7/2010	Complete: 6/4/2011	2066/CHE/2010	A product containing anntiinflammatory principles from green mussel *Perna viridis* L. and a process thereof	Examination request filed (27/9/11)
Provisional: 20/7/2010	Complete: 6/4/2011	2063/CHE/2010	A process to prepare naturalised *Artemia francesciana* from Indian subcontinent with high docosahexaenoic acid and trehalose for aquaculture applications	Examination request filed (27/9/11)
Provisional: 20/7/2010	Complete: 6/4/2011	2064/CHE/2010	A process to prepare antioxidant and antiinflammatory concentrates from brown and red seaweeds and a product thereof	Examination request filed (27/9/11)

Invitation of Expression of Interest (EOI) to commercialize Cadalmin™ GMe developed by Central Marine Fisheries Research Institute for use against arthritic pain has been published in CMFRI website and EOIs have been received from three firms.

CMFRI Publications

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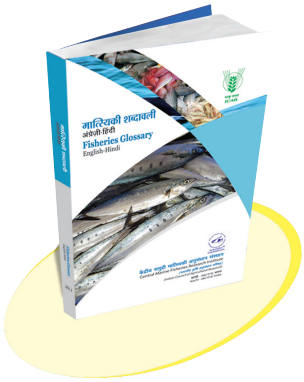
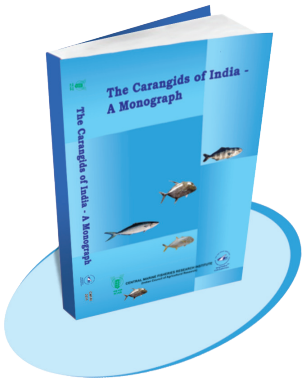
Sathiadhas, R., Narayanakumar, R. and Aswathy, N. 2011
Hardbound, 276p.



Fisheries Glossary: English-Hindi
Sheela, P. J. and Sasikala, E. eds. 2012
Hardbound, 297p.



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Hardbound, 437p.

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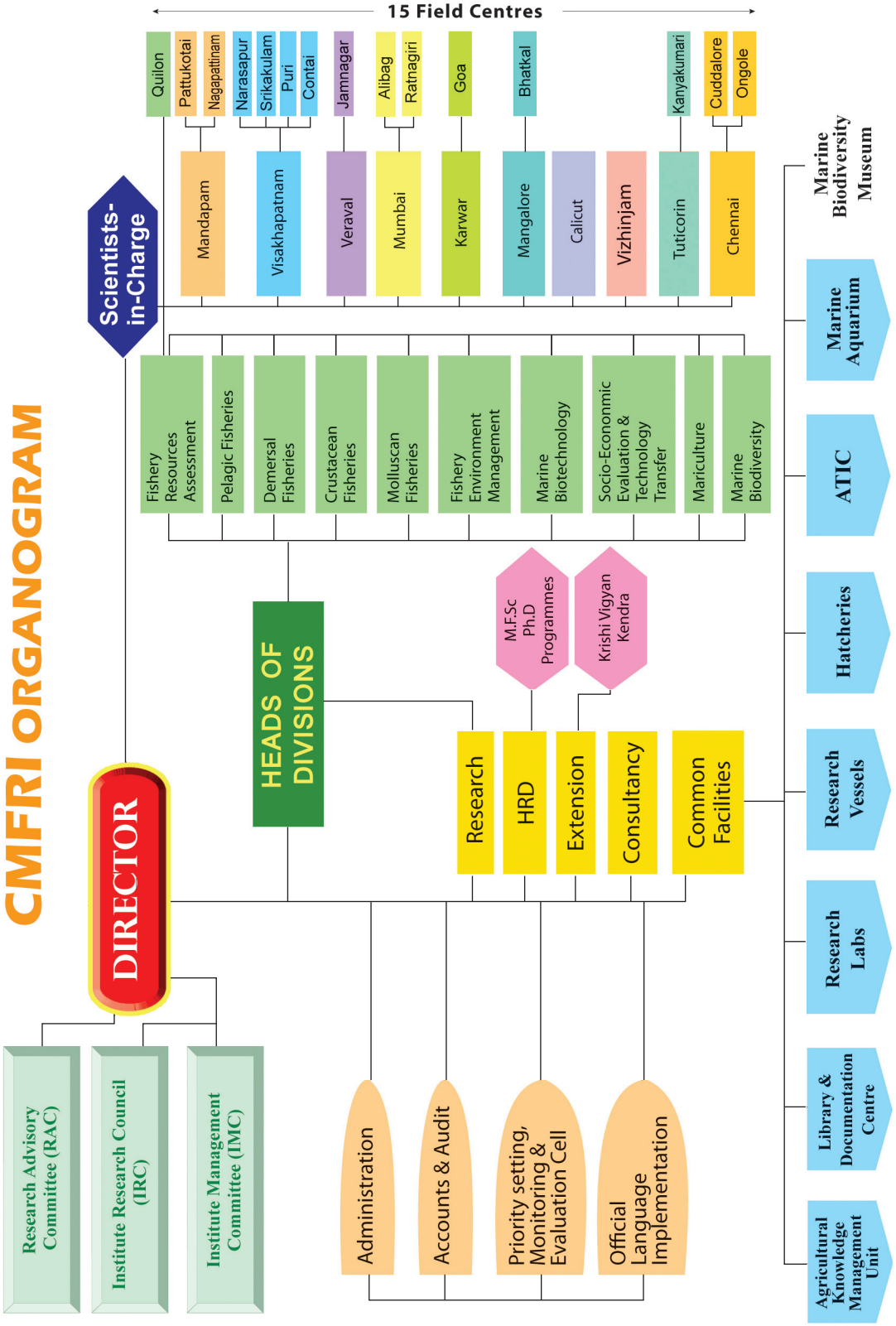
BUDGET 2011-12

The Budget and Expenditure under Non-Plan and Plan for the financial year 2011-12 in respect of CMFRI (Figures in ₹ lakhs)

Budget Head	Non-Plan		Plan	
Revenue	**Budget**	**Expenditure**	**Budget**	**Expenditure**
Estt. Charges	3200.00	3200.00	0.00	0.00
OTA	0.35	0.35	0.00	0.00
TA	21.00	21.00	60.00	60.00
Other Charges	316.00	316.00	450.00	450.00
Miscellaneous Expenses (Including HRD)	16.30	16.30	3.00	3.00
Works Repair & Maintenance				
Office building	306.00	306.00	0.00	0.00
Residential building	12.25	12.25	0.00	0.00
Minor work	3.00	3.00	0.00	0.00
Capital				
Information Technology	7.00	7.00	60.00	60.00
Equipment	75.00	75.00	212.00	212.00
Furniture	0.00	0.00	10.00	10.00
Library	0.00	0.00	40.00	40.00
Vessel	0.00	0.00	100.00	100.00
Works	0.00	0.00	1084.00	1084.00
Minor Works	25.00	25.00	0.00	0.00
Total	**3981.90**	**3981.90**	**2019.00**	**2019.00**

Pension		
	Budget	Expenditure
Pension	2535.00	2535.00
Loans and Advances		
	Budget	Expenditure
Loans and Advances	30.00	29.64
Other projects		
Non-Plan Schemes		12.60
NAIP		209.16
Other Plan Schemes		28.24
Deposit Schemes		185.97
KVK, Narakkal		74.33
Consultancies		63.17
NICRA		850.24
Revenue Receipts		
Head	Target	Achievement
Revenue receipts	66.15	95.72
Sale of Assets		0.35
Interest on short term deposits		63.89
Recovery of Loans		47.03


CMFRI ORGANOGRAM
DIRECTOR
Research Advisory Committee (RAC)
Institute Research Council (IRC)
Institute Management Committee (IMC)
HEADS OF DIVISIONS
Scientists-in-Charge
15 Field Centres
Quilon
Pattukotai
Nagapattinam
Narasapur
Srikakulam
Puri
Contai
Jamnagar
Alibag
Ratnagiri
Goa
Bhatkal
Kanyakumari
Cuddalore
Ongole
Mandapam
Visakhapatnam
Veraval
Mumbai
Karwar
Mangalore
Calicut
Vizhinjam
Tuticorin
Chennai
Fishery Resources Assessment
Pelagic Fisheries
Demersal Fisheries
Crustacean Fisheries
Molluscan Fisheries
Fishery Environment Management
Marine Biotechnology
Socio-Economic Evaluation & Technology Transfer
Mariculture
Marine Biodiversity
M.F.Sc Ph.D Programmes
Krishi Vigyan Kendra
Research
HRD
Extension
Consultancy
Common Facilities
Administration
Accounts & Audit
Priority setting, Monitoring & Evaluation Cell
Official Language Implementation
Marine Biodiversity Museum
Marine Aquarium
ATIC
Hatcheries
Research Vessels
Research Labs
Library & Documentation Centre
Agricultural Knowledge Management Unit

Staff strength as on 31.03.2012

Staff Strength as on 31st March 2012 including KVK, Narakkal

Name of Pos	Sanctioned		In-position		Vacant	
	CMFRI	KVK	CMFRI	KVK	CMFRI	KVK
RMP	1	-	1	-	0	-
Scientific	173	1	111	1	62	-
Technical	303	11	273	9	30	2
Administrative	144	2	119	2	25	-
Supporting	238	2	161	2	77	-
Auxiliary	4	-	3	-	1	-
Total	863	16	668	14	195	2
	879		**682**		**197**	

List of staff members as on 31.03.2012 (not a gradation list)

Scientist

Sl.no.	Name of Employee	Designation
	CMFRI, Kochi	
1	Dr. G. Syda Rao	Director & Principal Scientist
2	Dr. (Mrs.) V. Kripa	Principal Scientist & Head, FEMD
3	Dr. K. Sunilkumar Mohammed	Principal Scientist & Head, MFD
4	Dr. P.U. Zachariah	Senior Scientist & Head, DFD
5	Dr. K.K. Vijayan	Principal Scientist & Head,MBTD
6	Dr. Grace Mathew	Principal Scientist, Head-in-charge, Mariculture Division & PFD
7	Dr. R. Narayanakumar	Senior Scientist & Head, SEETTD
8	Dr. T.V. Sathianandan	Senior Scientist & Head-in-charge, FRAD
9	Dr. P.C. Thomas	Principal Scientist
10	Dr. (Mrs.) Josileen Jose	Senior Scientist
11	Dr. (Mrs.) Imelda Joseph	Senior Scientist
12	Dr. (Mrs.) D. Prema	Senior Scientist
13	Dr. K. Madhu	Senior Scientist
14	Dr. (Mrs.) K.S. Sobhana	Senior Scientist
15	Dr. (Mrs.) Shoji Joseph	Senior Scientist
16	Dr. E.M. Abdusamad	Senior Scientist
17	Dr. P. Vijayagopal	Senior Scientist
18	Dr. J. Jayasankar	Senior Scientist
19	Dr. C. Ramachandran	Senior Scientist
20	Dr. (Mrs.) Molly Varghese	Senior Scientist
21	Dr. (Mrs.) Somy Kuriakose	Senior Scientist
22	Dr. Boby Ignatius	Senior Scientist
23	Dr. V.P. Vipin Kumar	Senior Scientist
24	Dr. (Mrs.) Rema Madhu	Senior Scientist
25	Dr. T.M. Najmudeen	Senior Scientist
26	Dr. Shyam S. Salim	Senior Scientist
27	Dr. R. Jeyabaskaran	Senior Scientist
28	Dr. K.K. Joshi	Senior Scientist
29	Smt. Mini. K.G.	Senior Scientist
30	Shri N.K. Sanil	Scientist (Selection Grade)
31	Smt. U. Ganga	Scientist (Selection Grade)
32	Smt. Rekha J. Nair	Scientist (Selection Grade)
33	Dr. Kajal Chakraborty	Scientist (Senior Scale)
34	Dr. S. Lakshmi Pillai	Scientist (Senior Scale)
35	Smt. Rekhadevi Chakraborty	Scientist
36	Shri Wilson T. Mathew	Scientist
37	Dr. Srinivasa Raghavan V	Scientist
38	Smt. N. Aswathy	Scientist (Senior Scale)
39	Shri V. Venkatesan	Scientist
40	Dr. Pradeep M.A	Scientist
41	Shri Nenavath Rajendra Naik	Scientist
42	Ms. Indira Divipana	Scientist
43	Shri Pralaya Ranjan Behera	Scientist
44	Shri Renjith. L	Scientist
45	Shri Ramkumar	Scientist
46	Smt. Swathipriyanka Sen	Scientist
47	Dr. Shinoj Subramani	Programme Coordinator

Sl.no.	Name of Employee	Designation
	Mandapam R.C	
48	Dr. G. Gopakumar	Principal Scientist & Head, Mariculture Division & SIC
49	Dr. I. Rajendran	Senior Scientist
50	Dr. K. Vinod	Senior Scientist
51	Dr. A.K. Abdul Nazar	Senior Scientist
52	Dr. Rengarajan Jayakumar	Senior Scientist
53	Mrs. Sandhya Sukumaran	Scientist
54	Shri C Kalidas	Scientist
55	Dr. G. Tamilmani	Scientist
56	Dr. M. Sakthivel	Scientist
57	Shri Johnson B.	Scientist
58	Dr. P. Rameshkumar	Scientist
	Visakhapatnam R.C	
59	Dr. G. Maheswarudu	Principal Scientist & SIC
60	Dr. P. Laxmilatha	Senior Scientist
61	Shri Shubhadeep Ghosh	Senior Scientist
62	Shri Ritesh Ranjan	Scientist
63	Smt. Biji Xavier	Scientist
64	Kum. Muktha M.	Scientist
65	Shri Loveson Edward L.	Scientist
	Veraval R.C	
66	Shri K. Mohammed Koya	Scientist &SIC
67	Shri Sreenath K.R.	Scientist
68	Shri Gyanranjan Dash	Scientist
	Madras R.C	
69	Dr. E. Vivekanandan	Principal Scientist & SIC
70	Dr. A. Margaret Muthu Rathinam	Senior Scientist
71	Dr. Joe K. Kizhakudan	Senior Scientist
72	Dr. Vidya Jayasankar	Senior Scientist
73	Smt. Sobha Joe Kizhakudan	Scientist (Senior Scale)
74	Dr. P. Hemasankari	Scientist (Senior Scale)
75	Dr. Satyanarayan Sethi	Scientist
76	Dr. (Mrs.) R. Geetha	Scientist
	Mumbai R.C	
77	Dr. V.D. Deshmukh	Principal Scientist & SIC
78	Dr. Veerendra Veer Singh	Principal Scientist
79	Dr. Sujitha Thomas	Senior Scientist
80	Kum. Anulekshmi Chellappan	Scientist
	Mangalore R.C	
81	Dr. A.P. Dinesh Babu	Senior Scientist & SIC
82	Smt. Bindu Sulochanan	Scientist (Senior Scale)
83	Smt. Geetha Sasikumar	Scientist (Senior Scale)
84	Dr. P.S. Swathilekshmi	Scientist (Senior Scale)
85	Dr. Prathibha Rohit	Senior Scientist

86	Dr. K. Vijayakumaran (on Deputation)	Senior Scientist
87	Shri Saravanan R.	Scientist
88	Shri Purushottama G.B.	Scientist
	Karwar R.C	
89	Shri K.K. Philipose	Senior Scientist & SIC
90	Dr. S.R. Krupesa Sharma	Scientist (Senior Scale)
91	Dr. Jayasree Loka	Senior Scientist
92	Dr. Divu Damodaran	Scientist
	Calicut R.C	
93	Dr. P. Kaladharan	Principal Scientist & SIC
94	Dr. Gulshad Mohamed	Senior Scientist
95	Dr. P.K. Asokan	Senior Scientist
96	Dr. P.P. Manoj Kumar	Senior Scientist
97	Shri K.P. Said Koya	Scientist (Selection Grade)
	Tuticorin R.C	
98	Dr. M.S. Madan	Principal Scientist & SIC
99	Dr. M. Sivadas	Senior Scientist
100	Smt. P.T. Sarada	Senior Scientist
101	Dr. E. Dhanwanthari	Scientist (Senior Scale)
102	Dr. I. Jagdis	Senior Scientist
103	Dr. (Mrs.) C.P. Suja	Senior Scientist
104	Dr. (Smt.) Asha. P.S.	Senior Scientist
	Vizhinjam R.C	
105	Dr. (Mrs.) Rani Mary George	Principal Scientist & SIC
106	Dr. R. Sathiadhas	Principal Scientist
107	Dr. A.P. Lipton	Principal Scientist
108	Dr. N. Ramachandran	Principal Scientist
109	Dr. M.K. Anil	Senior Scientist
110	Smt. K.N. Saleela	Scientist (SS)
111	Smt. S. Jasmine	Scientist (Selection Grade)
112	Dr. B. Santhosh	Senior Scientist
113	Dr. (Mrs.) Reeta Jayasankar	Principal Scientist

Technical staff

Sl.no.	Name of Employee	Designation
	CMFRI, Kochi	
1	Shri N. Venugopal	T-7-8 (Technical Officer)
2	Dr. (Mrs.) Geetha Antony	T-7-8 (Technical Officer)
3	Shri P.K. Harikumar	T-7-8 (Technical Officer)
4	Shri V. Edwin Joseph	T-7-8 (Technical Officer-Library)
5	Shri J. Sreenivasan	T-7-8 (Technical Officer)
6	Smt. P.L. Ammini	T-7-8 (Technical Officer)
7	Shri S. Haja Najeemudeen	T-6 (Technical Officer)
8	Shri N. Viswanathan	T-6 (Technical Officer-Civil)
9	Smt. E.K. Uma	T-6 (TO - Hindi Translator)
10	Smt. K. Ramani	T-6 (Technical Officer)
11	Dr.(Mrs.) S. Girijakumari	T-6 (Technical Officer-Library)
12	Shri P.S. Anilkumar	T-6 (Technical Officer)
13	Shri Mathew Joseph	T-6 (Technical Officer)
14	Shri C.K. Sajeev	T-6 (Technical Officer)
15	Dr. V. Mohan	T-6 (Technical Officer-Library)
16	Smt. P. Geetha	T-6 (Technical Officer-Library)
17	Shri M.G. Sivadasan	T-5 (Technical Officer-Electrical)
18	Smt. K.K. Valsala	T-5 (Technical Officer)
19	Shri S. Yadavayya	T-5 (T.O. - Motor Driver)
20	Shri R. Ramachandran Nair	T-5 (T.O. - Motor Driver)
21	Shri K.K. Sankaran	T-5 (Technical Officer - Artist)
22	Shri M.P. Paulton	T-5 (Technical Officer -Training)
23	Smt. G. Shylaja	T-5 (Technical Officer)
24	Shri L.R. Khambadkar	T-5 (Technical Officer)
25	Smt. K.V. Rema	T-5 (Technical Officer)
26	Smt. E. Sasikala	T-5 (Tech. Officer - Hindi Translator)
27	Smt. P.M. Geetha	T-5 (Technical Officer - Museum)
28	Shri J. Narayanaswamy	T-5 (Technical Officer)
29	Smt. Jenni. B	T-5 (Technical Officer)
30	Smt. K.P. Salini	T-5 (Technical Officer)
31	Shri K.M. Venugopalan	T-5 (Technical Officer)
32	Shri K.K. Surendran	T-5 (Technical Officer)
33	Shri M.N. Kesavan Elayathu	T-5 (Technical Officer)
34	Shri V.J. Thomas	T-5 (Technical Officer)
35	Smt. P.K. Seetha	T-5 (Technical Officer)
36	Shri A. Padmanabha	T-5 (Technical Officer- Electrical)
37	Shri K.P. George	T-5 (Technical Officer)
38	Smt. M.R. Beena	T-5 (Technical Officer)
39	Shri M.B. Seynudeen	T-5 (Technical Officer)
40	Smt. P.T. Mani	T-5 (Technical Officer)
41	Shri K. Anandan	T-5 (Technical Officer)
42	Smt. Lata L. Khambadkar	T-5 (Technical Officer)
43	Shri Sijo Paul	T-5 (Technical Officer)
44	Shri K.N. Pushkaran	T-4 (Senior Technical Assistant)
45	Shri P.K. Baby	T-4 (Senior Technical Assistant)
46	Shri A.Y. Jacob	T-4 (Senior Technical Assistant)
47	Shri K.G. Baby	T-4 (Senior Technical Assistant)
48	Shri Manjeesh .R	T-1 (Computer Application)
49	Smt. Sindhu K. Augustine	T-4 (Senior Technical Assistant)
50	Shri V.K. Suresh	T-4 (Senior Technical Assistant)
51	Shri K.G. Radhakrishnan Nair	T-3 (Motor Driver)
52	Shri N.K. Harshan	T-3 (Technical Assistant)
53	Shri S. Nandakumar Rao	T-3 (Technical Assistant)
54	Shri D. Prakasan	T-3 (Technical Assistant)
55	Shri P.S. Alloycious	T-3 (Technical Assistant)
56	Shri Arun Surendran	T-3 (Technical Assistant)
57	Shri Retheesh T.	T-3 (Technical Assistant)
58	Shri Baby Mathew	T-2 (Motor Driver)
59	Shri K.M. David	T-2 (Artist)
60	Shri K.C. Hezhakiel	T-2 (Junior Technical Assistant)
61	Shri C.V. Jayakumar	T-2 (Press & Editorial)
62	Shri David Babu	T-2 (Junior Technical Assistant)
63	Shri P.R. Abhilash	T-1 (Exhibition Assistant)
64	Shri M. Radhakrishnan	T-1 (Field Assistant)
65	Shri M.P. Mohandas	T-1 (Field Assistant)
66	Shri T.V. Shaji	T-1 (Field Assistant)
	KVK, Narakkal	
67	Smt. P. Sreelatha	T-7-8 (Technical Officer)
68	Shri B. Suresh Kumar	T-6 (Technical Officer - Training)
69	Shri Shoji Joy Edison	T-6 (SMS)
70	Shri Vijendra Kumar Meena	T-6 (SMS)
71	Shri F. Pushparaj Anjelo	T-6 (SMS)
72	Dr. Karikkathil Smitha Sivadasan	T-6 (SMS)
73	Shri Vikas P.A	T-6 (SMS)
74	Shri V.K. Manu	T-4 (Programme Assistant - Computer)
75	Ms. Dipti N.V	T-4 (Programme Assistant - Laboratory Technician)
	Mandapam R.C	
76	Shri P. Chithamparam	T-6 (Technical Officer-Library)
77	Shri M.R. Arputharaj	T-6 (Technical Officer)
78	Shri N. Ramamurthy	T-5 (Technical Officer - Museum)
79	Shri I. Mendonza Xavier	T-5 (Technical Officer - Draughtsman)
80	Shri P.M.A. Muheedu	T-5 (Technical Officer - Deckhand)
81	Shri D. Anandan	T-5 (Technical Officer - Deckhand)
82	Shri P. Muthukrishnan	T-5 (Technical Officer - Skin Diver)
83	Shri G. Subbaraman	T-5 (Technical Officer)
84	Shri A. Gandhi	T-4 (Senior Technical Assistant)

85	Shri V. Sethuraman	T-4 (Senior Technical Assistant)
86	Shri V. Sathyanesan	T-4 (Senior Library Assistant)
87	Shri N. Boominathan	T-3 (Technical Assistant)
88	Shri A. Vairamani	T-3 (Technical Assistant)
89	Shri A. Shanmughavel	T-3 (Technical Assistant)
90	Shri G. Hanumantha Rao	T-3 (Technical Assistant)
91	Shri M. Anbarasu	T-3 (Technical Assistant)
92	Shri A. Palanichamy	T-I-3 (Technical Assistant)
93	Shri K.U. Raman	T-I-3 (Motor Driver)
94	Shri.P.Villan	T-2 (Junior Technical Assistant)
95	Shri M. Asokan	T-2 (Painter-cum-Polisher)
96	Shri K. Shanmughanathan	T-1 (Field Assistant)
97	Shri R. Selvakumar	T-1 (Field Assistant)
98	Shri S. Murugaboopathy	T-1 (Field Assistant)
99	Shri N. Ramakrishnan	T-1 (Field Assistant)
100	Shri P. Rajendran	T-1 (Field Assistant)
101	Shri Vijaya Karthikeyan	T-1 (Electrician)
102	Shri M. Palanichamy	T-1 (Electrician)
	Visakhapatnam R.C	
103	Shri K. Ram Mohan	T-6 (Technical Officer)
104	Shri Sailada Satya Rao	T-6 (Technical Officer)
105	Dr. Madhumita Das	T-6 (Technical Officer)
106	Dr. Phalguni Pattnaik	T-6 (Technical Officer)
107	Dr. Biswajit Dash	T-6 (Technical Officer)
108	Shri K. Narayana Rao	T-5 (Technical Officer)
109	Shri J. Bhuvaneswara Verma	T-5 (Technical Officer)
110	Shri M. Chandrasekhar	T-5 (Technical Officer)
111	Shri M. Samuel Sumithrudu	T-5 (Technical Officer)
112	Shri M. Prasada Rao	T-5 (Technical Officer)
113	Shri C. H. Ellithathayya	T-5 (Technical Officer)
114	Shri T. Nageswara Rao	T-4 (Senior Technical Assistant)
115	Shri P.Venkataramana	T-4 (Senior Technical Assistant)
116	Shri R.V.D. Prabhakar	T-4 (Senior Technical Assistant)
117	Shri Mamidi Satishkumar	T-3 (Technical Assistant)
118	Shri Y.V.S. Suryanarayana	T-3 (Technical Assistant)
119	Ms. Veena Shettigar	T-3 (Technical Assistant)
120	Shri K. Lakshminarayana	T-2 (Motor Driver)
121	Shri S. Tatabhai	T-2 (Junior Technical Assistant)
122	Shri R.P.Venkatesh	T-1 (Fitter)
123	Shri Sangaru Padmaja Rani	T-1 (Field Assistant)
124	Shri Durga Suresh Relangi	T-1 (Field Assistant)
	Veraval R.C	
125	Shri Suresh Kumar Mojjada	T-6 (Technical Officer)
126	Shri Fofandi Mahendrakumar	T-6 (Technical Officer)
127	Shri H.K. Dhokia	T-5 (Technical Officer)
128	Shri Y.D. Savaria	T-5 (Technical Officer)
129	Shri Govindnath Chudasama	T-5 (T.O. - Motor Driver)
130	Shri Mangalsingh Surajsingh Zala	T-5 (Technical Officer)
131	Shri Vanvi Jayaanthilal Dayabhai	T-4(Senior Technical Assistant)
132	Shri Ladani Amrutlal Arjunbhai	T-4 (Senior Technical Assistant)
133	Shri Polara Jamnadas Premji	T-4 (Senior Technical Assistant)
134	Shri Chudasama Ramji Raja	T-3 (Technical Assistant)
135	Ms. Bharadiya Sangita Aravindkumar	T-3 (Technical Assistant)
136	Shri H.M. Bhint	T-2 (Junior Technical Assistant)
137	Shri Shiju P.	T-1 (Field Assistant)
138	Shri S. Pradeep	T-1 (Field Assistant)
139	Shri M. Rajeshkumar Cahndubhai	T-1 (Field Assistant)
	Madras R.C	
140	Shri R. Somu	T-5 (Technical Officer)
141	Shri D. Pugazhendi	T-6 (Technical Officer)
142	Shri S. Subramani	T-6 (Technical Officer)
143	Shri S. Seetharaman	T-5 (Technical Officer)
144	Shri P.Thirumilu	T-6 (Technical Officer)
145	Shri S. Mohan	T-6 (Technical Officer)
146	Shri P. Poovannan	T-5 (Technical Officer)
147	Shri Ahmed Kamal Basha	T-5 (Technical Officer)
148	Shri S. Rajapackiam	T-6 (Technical Officer)
149	Shri S. Chandrasekhar	T-6 (Technical Officer)
150	Shri G. Srinivasan	T-5 (Technical Officer)
151	Smt. S. Gomathy	T-5 (Technical Officer)
152	Shri S. Sankaralingam	T-5 (Technical Officer)
153	Shri V.A. Leslie	T-5 (Technical Officer)
154	Shri N. Rudhramurthy	T-5 (Technical Officer)
155	Shri C. Manibal	T-5 (Technical Officer-Deckhand)
156	Shri S. Ganesan	T-5 (Technical Officer-Deckhand)
157	Shri V.S. Gopal	T-5 (Technical Officer)
158	Shri S. Rajan	T-3 (Technical Assistant)
159	Shri K.S. Shaik Mohamed Yousuf	T-3 (Technical Assistant)
160	Shri S. Selvanidhi	T-2 (Junior Technical Assistant)
161	Shri M. Ravindran	T-2 (Junior Technical Assistant)
162	Smt. I. Santhosi	T-2 (Junior Technical Assistant)
163	Shri R.Vasu	T-1 (Field Assistant)
164	Shri V. Joseph Xavier	T-1 (Field Assistant)
165	Shri R. Sunder	T-1 (Field Assistant)
	Mumbai R.C	
166	Shri Nilesh Anil Pawar	T-6 (Technical Officer)
166	Shri Nilesh Anil Pawar	T-6 (Technical Officer)
167	Shri Kishore Balaji Wagmare	T-5 (Technical Officer)
168	Shri A.D. Sawant	T-5 (Technical Officer)
169	Shri R. Dias Johny	T-5 (Technical Officer)
170	Shri C.J. Josekutty	T-5 (Technical Officer)
171	Shri B.B. Chavan	T-5 (Technical Officer)
172	Shri J.D. Sarang	T-5 (Technical Officer)
173	Shri Baban N. Katkar	T-5 (Technical Officer)
174	Shri B.G. Kalbate	T-4 (Senior Technical Assistant)
175	Shri Thakurdas	T-4 (Senior Technical Assistant)
176	Shri S.D. Kamble	T-4 (Senior Technical Assistant)
177	Shri A.Y. Mestry	T-4 (Senior Technical Assistant)
178	Shri Sujit S.K.	T-4 (Senior Technical Assistant)
179	Shri D.G. Jadhav	T-4 (Senior Technical Assistant)
180	Shri Punam Ashok Khandagle	T-3 (Technical Assistant)
181	Shri Suresh Krishnaro Kamble	T-3 (Technical Assistant)
182	Shri Jayadev S. Hotagi	T-3 (Technical Assistant)
183	Shri Vaibhav Dinkar Mhatre	T-3 (Technical Assistant)
184	Shri Sashikant R. Yadav	T-2 (Motor Driver)
185	Shri Umesh Hari Rane	T-2 (Junior Technical Assistant)
186	Shri Prabhakar Sankar Salvi	T-2 (Junior Technical Assistant)
187	Shri M.P. Jadhav	T-1 (Field Assistant)
	Mangalore R.C	
188	Smt. Uma S. Bhat	T-5 (Technical Officer)
189	Shri G. Subramania Bhat	T-6 (Technical Officer)
190	Shri B. Sridhara	T-5 (Technical Officer)
191	Shri S. Kemparaju	T-5 (Technical Officer)
192	Shri N. Chennappa Gowda	T-5 (Technical Officer)
193	Shri Y. Muniyappa	T-5 (Technical Officer)
194	Shri R. Appayya Naik	T-4 (Senior Technical Assistant)
195	Shri V. Lingappa	T-3 (Technical Assistant)
196	Shri G. Sampathkumar	T-3 (Technical Assistant)
197	Shri M. Chaniappa	T-3 (Technical Assistant)
198	Shri G.D. Nataraja	T-3 (Technical Assistant)
199	Ms. Lavanya S.	T-3 (Technical Assistant)
200	Shri P. Harshakumar	T-2 (Motor Driver)
201	Shri Karamathullah Sahib. P	T-1 (Field Assistant)
	Karwar R.C	
202	Shri K.C. Pandurangachar	T-5(Technical Officer)
203	Shri C.K. Dinesh	T-5(Technical Officer)
204	Shri Narayan G Vaidya	T-5 (Technical Officer)
205	Shri S. Satyanarayan V. Pai	T-4 (Senior Technical Assistant)
206	Shri C.G. Ulvekar	T-3 (Technical Assistant)
207	Shri Narsimhulu Sadhu	T-3 (Technical Assistant)
208	Ms. Sonali S.Mhaddolkar	T-3 (Technical Assistant)
209	Shri Laxman Shanker Korabu	T-2 (Skin Diver)
210	Shri N. Selvakumar	T-1 (Field Assistant)
211	Ms. Dhanya G.	T-1 (Technical Assistant)
212	Shri Kodi Srinivasa Rao	T-3 (Technical Assistant)
	Calicut R.C	
213	Shri V.A. Kunhikoya	T-5 (Technical Officer)
214	Smt. V.K. Janaki	T-5 (Technical Officer)
215	Shri V.G. Surendranathan	T-5 (Technical Officer)

216	Shri M.P. Sivadasan	T-5 (Technical Officer)
217	Shri K. Chandran	T-5 (Technical Officer)
218	Shri P.P. Pavithran	T-5 (Technical Officer)
219	Shri M.M. Bhaskaran	T-4 (Senior Technical Assistant)
220	Shri K.C. Pradeep Kumar	T-4 (Senior Technical Assistant)
221	Shri A. Anasukoya	T-4 (Senior Technical Assistant)
222	Shri N.P. Ramachandran	T-3 (Technical Assistant)
223	Shri C. Chandran	T-3 (Technical Assistant)
224	Smt. M.V. Valsala	T-2 (Junior Technical Assistant)
225	Shri M.N. Sathyan	T-2 (Motor Driver)
	Tuticorin R.C	
226	Shri K. Muthuvel	T-2 (Motor Driver)
227	Shri K. Diwakar	T-6 (Technical Officer)
228	Shri G. Arumugham	T-6 (Technical Officer)
229	Shri M. Bose	T-5 (Technical Officer)
230	Shri M. Chellappa	T-5 (Technical Officer)
231	Shri R. Sekhar	T-5(Technical Officer -Deckhand)
232	Shri S. Enasteen	T-5(Technical Officer -Deckhand)
233	Shri S. Mohamed Sathakathullah	T-4 (Senior Technical Assistant)
234	Shri U. Jeyaram	T-4 (Senior Technical Assistant)
235	Shri N. Jesuraj	T-4(Skin Diver)
236	Shri S. Sekar V. Rayer	T-4 (Skin Diver)
237	Shri J. Padmanathan	T-3 (Technical Assistant)
238	Shri Ashok Maharshi	T-3 (Technical Assistant)
239	Shri P. Muniasamy	T-I-3 (Deckhand)
240	Shri B. Thangaraj	T-I-3 (Junior Technical Assistant)
241	Shri S.K. Gurusamy	T-I-3 (Motor Driver)
242	Shri K. John James	T-1 (Field Assistant)
243	ShriK.P. Kanthan	T-2 (Junior Technical Assistant)
	Vizhinjam R.C	
244	Shri S. Ramachandran Nair	T-5 (TO-Motor Driver)
245	Shri K.K. Suresh	T-5 (Technical Officer)
246	Shri K.T. Thomas	T-5 (Technical Officer)
247	Smt. T.A. Omana	T-5 (Technical Officer)
248	Shri Jose Kingsly	T-5(Technical Officer)
249	Shri A. Udayakumar	T-5 (Technical Officer)
250	Shri V.P. Benziger	T-5 (Technical Officer)
251	Shri P. Hillary	T-4 (Deckhand)
252	Shri C. Unnikrishnan	T-4 (Senior Technical Assistant)
253	Shri B. Raju	T-3 (Technical Assistant)
254	Shri K. Solaman	T-I-3 (Technical Assistant)
	Aligbag F.C	
255	Shri Ramesh B. Rao	T-4 (Senior Technical Assistant)
	Bhatkal F.C	
256	Shri Ganesh Bhatkal	T-5 (Technical Officer)
257	Shri Udaya V. Arghekar	T-4 (Senior Technical Assistant)
	Contai F.C	
258	Shri Pulin Behari Dey	T-5 (Technical Officer)
259	Shri Swapan Kumar Kar	T-4 (Senior Technical Assistant)
260	Shri Bijoy Krishna Burman	T-4 (Senior Technical Assistant)
	Cuddalore F.C	
261	Shri M. Manivasagam	T-6 (Technical Officer)
262	Shri P. Jaiganesh	T-3 (Technical Assistant)
263	Shri T. Nagalingam	T-1 (Field Assistant)
	Goa F.C	
264	Shri Prakash C. Shetty	T-4 (Senior Technical Assistant)
265	Shri M.E. Durgekar	T-3 (Technical Assistant)
	Jamnagar F.C	
266	Shri Makadia B.V.	T-5 (Technical Officer)
	Kanyakumari F.C	
267	Shri A. Prosper	T-5 (Technical Officer)
268	Shri P. Paul Sigamony	T-4 (Senior Technical Assistant)
	Kovalam F.L.	
269	Shri R. Ponniah	T-4(Sr.T A -Electrician)
	Nagapattinam F.C	
270	Shri N. Vaithianathan	T-5 (Technical Officer)
	Narsapur F.C	
271	Shri N. Burayya	T-4 (Senior Technical Assistant)
	Ongole F.C	
272	Shri G. Sudhakar	T-4 (Senior Technical Assistant)
273	Shri S.V. Subba Rao	T-2 (Junior Technical Assistant)
	Pattukottai F.C	
274	Shri A. Kumar	T-6 (Technical Officer)
275	Shri A. Ramakrishnan	T-5 (Technical Officer)
	Puri F.C	
276	Shri P. Venkatakrishna Rao	T-5 (Technical Officer)
277	Shri Sukhdev Bar	T-5 (Technical Officer)
	Quilon F.C	
278	Shri Thomas Kuruvila	T-4 (Senior Technical Assistant)
	Ratnagiri F.C	
279	Shri Bashir Ahmed Adam Shilodar	T-4 (Senior Technical Assistant)
280	Shri D.D. Sawant	T-4 (Senior Technical Assistant)
281	Shri Kishor Raghunath Mainkar	T-4 (Senior Technical Assistant)
	Srikakulam F.C	
282	Shri V. Achuta Rao	T-5 (Technical Officer)

Administrative Staff

Sl.no.	Name of Employee	Designation
1	Shri Rakesh Kumar	Chief Administrative Officer
2	Shri A.V. Joseph	Senior Finance & Accounts Officer
3	Smt. D. Geetha	Administrative Officer
4	Smt. P.J. Sheela	Assistant Director (OL)
5	Smt. Christina Joseph	Assistant Administrative Officer
6	Shri P.V. Devassy	Assistant Administrative Officer
7	Smt. Meera. K.N.	Assistant Administrative Officer
8	Smt. C.M. Jenny	Assistant Administrative Officer
9	Smt. V.K. Sobha	Assistant Administrative Officer
10	Shri P. Krishnakumaran	Assistant Finance & Accounts Officer
11	Shri Thomas Joy	Assistant Finance & Accounts Officer
12	Smt. A.K. Omana	Private Secretary
13	Shri C.N. Chandrasekharan	Private Secretary
14	Smt. N. Ambika	Private Secretary
15	Smt. N.R. Lethadevi	Personal Assistant
16	Smt. K.V. Sajitha	Personal Assistant
17	Shri R. Chandrakesa Shenoi	Personal Assistant
18	Smt. P.K. Anitha	Personal Assistant
19	Shri C.D. Manoharan	Personal Assistant
20	Smt. P. Vineetha	Personal Assistant
21	Shri K.N. Murali	Personal Assistant
22	Smt. Bindu Sanjeev	Personal Assistant
23	Smt. Ponnamma Radhakrishnan	Assistant
24	Shri K. Ramadasan	Assistant
25	Smt. P.S. Sumathy	Assistant

26	Smt. V. Parukutty	Assistant
27	Shri V.C. Subhash	Assistant
28	Smt. M.G. Chandramathy	Assistant
29	Smt. M. Safiyabi	Assistant
30	Shri C. Jayakanthan	Assistant
31	Shri P.P. Chandrasekharan Nair	Assistant
32	Shri M. Balaraman	Assistant
33	Smt. G. Ambika	Assistant
34	Smt. N.K. Suseela	Assistant
35	Shri K. Baburajan	Assistant
36	Smt. K.K. Kousallia	Assistant
37	Smt. V. Jayalakshmi	Assistant
38	Smt. Moly Lazer	Assistant
39	Smt. K. Smitha	Stenographer Grade III
40	Smt. Saritha L.	Stenographer Grade III
41	Smt. Dhanya M.B	Stenographer Grade III
42	Shri C.K. Sivadas	Upper Division Clerk
43	Shri Tomy Prince. M.J.	Upper Division Clerk
44	Smt. P.K. Mary	Upper Division Clerk
45	Smt. Binny Cherian	Upper Division Clerk
46	Smt. Gouri Hareendran	Upper Division Clerk
47	Smt. D. Lalithambika Amma	Upper Division Clerk
48	Shri P.K. Ravindran	Upper Division Clerk
49	Smt. T.C. Chandrika	Upper Division Clerk
50	Smt. C.A. Leela	Upper Division Clerk
51	Shri A.K. Kunjipalu	Upper Division Clerk
52	Smt. C. Devaki	Upper Division Clerk
53	Shri K.S. Ajith	Upper Division Clerk
54	Smt. Manjusha G. Menon	Upper Division Clerk
55	Shri K. Jerald Raja	Upper Division Clerk
56	Shri K.P. John	Upper Division Clerk
57	Smt Annies Mary Paulose	Upper Division Clerk
58	Shri T.K. Sumesh	Upper Division Clerk
59	Shri K.S. Sunil Raj	Upper Division Clerk
60	Shri E.A. Roopesh	Lower Division Clerk
61	Smt. Manju Jose	Lower Division Clerk
62	Smt. Deepa P.N.	Lower Division Clerk
63	Smt. Febeena P.A.	Lower Division Clerk
64	Shri Sunil A.T	Lower Division Clerk
65	Shri Joseph Mathew	Lower Division Clerk
66	Smt. Sujatha K.K	Lower Division Clerk
67	Shri S. Sreekumar	Lower Division Clerk
68	Shri C.P. Umasankar	Lower Division Clerk
69	Shri N.K. Mohanan	Assistant
70	Shri Rincy K.R.	Stenographer Grade III
	Mandapam R.C	
71	Shri A. Yagappan	Assistant Administrative Officer
72	Shri M. Radha Krishnan	Junior Accounts Officer
73	Smt. N. Gomathi	Private Secretary
74	Smt. S. Parisa	Assistant
75	Shri N. Natarajan	Assistant
76	Smt. M. Rameswari	Assistant
77	Shri G.K. Rajan	Lower Division Clerk
78	Shri M. Shahul Hameed	Lower Division Clerk
79	Shri B. Balasubramanian alias James	Lower Division Clerk
	Visakhapatnam R.C	
80	Smt. K.C. Girija	Assistant Administrative Officer
81	Smt. B. Gauri	Assistant
82	Smt. D. Madhavi Latha	Upper Division Clerk
83	Shri P. Krishna Rao	Upper Division Clerk
84	Smt. N.C. Saroja	Upper Division Clerk
85	Smt. G. Hemlata	Lower Division Clerk
86	Shri L. Pydi Raju	Lower Division Clerk
	Veraval R.C	
87	Shri M.R. Wadadekar	Assistant Administrative Officer
88	Shri J.N. Jambudiya	Assistant
89	Shri Vanvi Mansukhlal Madhavji	Upper Division Clerk
	Madras R.C	
90	Smt. Leelavathi	Personal Assistant
91	Smt. G. Abitha	Assistant
92	Shri Rishikesh Aandi	Assistant
93	Smt. P. Thankaleelal	Assistant
94	Shri S. Yuvarajan	Upper Division Clerk
95	Smt. S. Anjalidevi	Lower Division Clerk
	Mumbai R.C	
96	Smt. Ashlesha Ashok Sawant	Assistant
97	Shri Augustus Julin Raj	Assistant
98	Shri Vinod P. Bhagayatkar	Upper Division Clerk
	Mangalore R.C	
99	Smt. Martha R. Mascarenhas	Assistant
100	Shri U. Purandhara Shetty	Upper Division Clerk
	Karwar R.C	
101	Shri Gangadhar B. Naik	Assistant
102	Shri Ratan P. Naik	Lower Division Clerk
	Calicut R.C	
103	Shri R. Sreenivasan	Assistant
104	Smt. K.P. Shylaja	Upper Division Clerk
105	Smt. K. Balamani	Assistant
106	Smt. N.G. Supriya	Upper Division Clerk
	Tuticorin R.C	
107	Smt. S. Sarada	Assistant
108	Smt. C. Rajeswari	Assistant
109	Shri M. Samuthiram	Upper Division Clerk
110	Smt. T. Mahalakshmi	Upper Division Clerk
111	Shri J. Vinoth Prabhu Vaz	Upper Division Clerk
112	Smt. C. Pushparani	Upper Division Clerk
113	Shri A. Dickson Jebaraj	Upper Division Clerk
114	Shri W. Sathyavan Neelraj	Upper Division Clerk
115	Smt. R. Anantharani	Lower Division Clerk
	Vizhinjam R.C	
116	Smt. K. Santha	Assistant Administrative Officer
117	Shri S. Erishikesan	Assistant
118	Smt. K. Latha	Assistant
119	Shri A. Yesudhas	Lower Division Clerk
120	Shri R. Balakrishnan	Lower Division Clerk
121	Smt. M.P. Kaladevi	Lower Division Clerk

Skilled Support Staff

Sl.no.	Name of Employee
	CMFRI, Kochi
1	Shri B. Zainudheen
2	Shri T. Sreedharan
3	Shri T.I. Soman
4	Shri T. Vijayakumar
5	Shri N.P. Mohanan
6	Shri K.C. Rajappan
7	Shri V.T. Ravi
8	Smt. A. Latha
9	Shri K.G. Jayaprasad
10	Shri P.D. Karunakaran
11	Shri E.J. James
12	Shri T.K. Antony
13	Shri V. Krishnan
14	Shri V.H. Venu
15	Shri N.V. Thambi
16	Smt. J. Sudhadevi

17 Smt. K.T. Prakasini
18 Smt. P.K. Usha
19 Shri K. Kunjuraman
20 Shri K. Thankappan
21 Shri M.D. Suresh
22 Shri P.B. Jeevaraj
23 Smt. Usha. S.
24 Smt. Sheela. P.P.
25 Shri P.V. Sunil
26 Smt. Shyamala. M.P.
27 Shri P.V. Joy
28 Shri P.M. Gireesh
29 Shri Sreekumar. K.M.
30 Shri Vijayan. M.T.
31 Shri V. Rajendran
32 Shri T. Rajesh Babu
33 Shri Jestin Joy. K.M.
34 Smt. P.K. Sujatha
35 Shri M.J. Joseph
36 Smt. Subaida. K.S.
37 Smt. S. Prasannakumari
38 Smt. K.S. Jeeji
39 Shri C.R. Mohanan
40 Smt. K. Parukutty
41 Shri Biju George
42 Shri Shaji. A.K.
43 Shri K. Murugan
44 Smt. T.R. Kumari
45 Shri R. Pydi Raju

KVK, Narakkal

46 Smt. Chinnamma Anjalo
47 Shri M.K. Anilkumar

Mandapam R.C.

48 Shri M. Govindaraj
49 Shri M. Athimoolam
50 Shri R. Sonaimuthu
51 Shri S. Murugan
52 Shri V. Narasimhabharathi
53 Shri P. Ramu
54 Shri J. Hameed Sultan
55 Shri K. Thangavelu
56 Shri U. Rajendran
57 Shri S.M. Sikkender Batcha
58 Shri M. Shanmugavelu
59 Shri I. Syed Sadiq
60 Shri K. Jeevanandam
61 Shri V. Muniasamy
62 Shri N. Nagamuthu
63 Smt. Subbulakshmi
64 Shri M. Saravana Kumar
65 Shri K. Anandan
66 Shri K. Ganesan
67 Shri K. Chandran
68 Shri N. Ramamoorthy
69 Shri B. Kathiresan
70 Shri K. Muniyasamy
71 Shri M. Ganesan
72 Shri M. Thayalan
73 Shri M. Saravanan
74 Shri K. Senthil Kumar
75 Smt. M. Saraswathi
76 Shri N. Thirupathi
77 Shri M. Jayasingh
78 Shri S. Karunanithi
79 Shri A. Bose
80 Shri K. Narayanan
81 Shri K. Krishnan

Visakhapatnam R.C

82 Shri R. Kanaka Raju
83 Shri D. Jaganna
84 Shri D. Bhaskara Rao
85 Shri C.H. Moshe
86 Shri D. Lingaraju
87 Shri Oggu China Venkateswarlu
88 Shri S. Srinivasulu

Veraval R.C

89 Shri A. Abubin Mehsam
90 Shri Haridas Khimdas Makwana
91 Shri Makwana Somapitha
92 Shri Ladani Dhirajlal Jamnadas
93 Shri Chudasama Karsan Punja
94 Shri Sangabhai Lakhabhai Paredi
95 Smt. Santok A. Bharada
96 Smt. Bhanuben L. Waghela

Madras R.C

97 Shri D. Pakkiri
98 Shri A. Janakiraman
99 Shri G. Chakrapani
100 Shri P. Selvaraj
101 Shri S. Imbamani
102 Shri M.P. Chandrasekharan
103 Shri Bareen Mohamed
104 Shri V. Sitaramacharyulu
105 Shri S. Chandrasekharan
106 Smt. R. Kalaiselvi
107 Shri R. Kumaran
108 Smt. R. Sarojini
109 Smt. M. Sundari

Mumbai R.C

110 Shri S.M. Tandel
111 Shri K.K. Baikar
112 Shri D.D. Jangam
113 Smt. Urmila S. Balmiki
114 Shri Bhangare Sunil Ramachandra

Mangalore R.C

115 Shri U.B. Sadasiva
116 Shri A. Keshava
117 Shri L.K. Suvarna
118 Shri D. Gangadhara Gowda
119 Shri S. Mahalinga Naik

Karwar R.C

120 Shri Subhash K. Naik
121 Shri Somayya S. Gonda
122 Shri Gopi X. Chodenkar
123 Smt. Somi M. Harijan
124 Shri Rajendra D. Hulswar
125 Smt. Pramila Harish Borkar
126 Shri Ramakant Shankar Harikantra
127 Shri Suresh Rumo Majalikar
128 Smt. Vijayalakshmi Y. Gamanagatti
129 Smt. Nandini Mayekar

Calicut R.C

130 Shri A. Sivadasan
131 Shri P. Dassan
132 Shri M.K. Chandran
133 Shri T.P. Renilkumar
134 Shri K.T. Mohanan
135 Smt. P. Renuka
136 Shri K. Sankaran
137 Shri P. Satheeshkumar
138 Shri M.P. Devadasan
139 Shri P.V. Gopalan

Tuticorin R.C

140 Shri K. Thankaraj
141 Shri V. Samayamuthu
142 Shri R. Uchimahali
143 Shri S. Balakrishnan
144 Shri S. Alagesan
145 Shri I. Ravindran
146 Shri S. Mariappan
147 Shri M. Soundrapandian
148 Shri M. Kalimuthu
149 Shri K. Subramanian
150 Smt. B. Koncies Mary
151 Shri S. Willington
152 Shri M. Joseph Sahayaraj
153 Shri N. Ramaswamy
154 Shri A. Paul Pondi
155 Smt. A. Usha Rani
156 Shri C.S. Santhanakumar

Vizhinjam R.C

157 Shri V. Viswanathan
158 Shri S. Anil
159 Shri B. Babu
160 Shri S. Mohanan
161 Shri A. Anukumar
162 Smt. T. Jayakumari
163 Shri S. Satheesh Kumar

Canteen Staff

Sl.no.	Name of Employee	Designation
	CMFRI, Kochi	
1	Shri P.V. George	Bearer
2	Shri M.V. Deassykutty	Bearer
3	Shri P.K. Purushan	Coffee/Tea maker

List of Projects (2011-2012)

In-house projects

Sl.No.	Project Code	Name of Project	Name of PI
1.	FRA/ASSESS/01	Development of knowledge based information system for marine fisheries sustainability	Dr.T.V. Sathianandan
2.	FRA/ASSESS/02	Decision support system for marine fisheries management	Dr. J. Jayasankar
3.	PEL/IDP/01	Management advisories for sustaining marine fisheries of Kerala and Lakshadweep	Dr. K.P. Said Koya
4.	PEL/IDP/02	Management advisories for sustaining marine fisheries for Karnataka and Goa	Dr. Prathibha Rohith
5.	PEL/IDP/03	Strategies for sustaining tuna fishery along the Indian coast	Dr. E.M. Abdussamed
6.	DEM/IDP/01	Management advisories for sustaining marine fisheries of Tamil Nadu and Puducherry	Dr. E. Vivekanandan
7.	DEM/IDP/02	Management advisories for sustaining marine fisheries of Gujarat	Shri. Muhammed Koya
8.	DEM/IDP/03	Carbon sequestration potential of Indian seaweeds	Dr. E. Vivekanandan
9.	CF/IDP/01	Management advisories for sustaining marine fisheries of Maharashtra	Dr.V.D. Deshmukh
10.	CF/IDP/02	Resource damage assessment in marine Fisheries:impact of selective fishing of juveniles and bycatch and discards in trawl fisheries	Dr. E.V. Radhakrishnan
11.	MF/IDP/01	Developing management advisories for sustaining marine fisheries of Andhra Pradesh	Dr. G. Maheswarudu
12.	MF/IDP/02	Application of trophic modeling in marine fisheries management	Dr. K.S. Mohamed
13.	CF/RE/03	Dynamics of recruitment process of penaeid prawns along the Indian coast	Dr.V.D. Deshmukh
14.	FEM/01	Impact of anthropogenic activities on coastal marine environment and fisheries	Dr. P. Kaladharan
15.	FEM/02	Impact and yield study of environmental changes on distribution shifts in small pelagics along the Indian coast	Dr.V. Kripa
16.	FEM/RE/03	Devolopment of fisheries ecosysytem restoration plans for critical marine habitats	Dr.V. Kripa
17.	MD/IDP/01	Technology development for seed production of shellfish	Dr. Joe K. Kizhakudan
18.	MD/IDP/02	Technological upgadation of molluscan Mariculture	Dr. P.K. Asokan

Sl.No.	Project Code	Name of Project	Name of PI
19.	MD/IDP/03	Development of broodstock, captive breeding and seed production techniques for selected marine food fishes and ornamental fishes	Dr. G. Gopakumar
20.	MD/IDP/04	Innovations of sea cage farming and development of sustainable Capture Based Aquaculture (CBA) systems	Dr. G. Syda Rao
21.	MD/IDP/05	Conservation mariculture of selected species	Dr. I. Jagadis
22.	MBTD/NUT/01	Formulation and evaluation of larval and growout feed for marine crabs, lobsters, ornamentals and cage farmed finfish	Dr. P. Vijayagopal
23.	MBTD/PATH/01	Pathogen profiling, diagnostics and health management in maricultured finfish and shelfish	Dr. K.K. Vijayan
24.	PNP/BIOT/02	Biotechnological applications in mariculture and conservation	Dr. P.C. Thomas
25.	MBD/RE/01	Understanding the threatened coral reef ecosystems of southern India and designing interventions aimed at their restorations	Dr. Mary K. Manisseri
26.	SEE/PEM/01	Benefit-cost assessment of marine fishery business and alternative investment options	Dr. R. Narayanakumar
27.	SEE/PMS/01	A diagnostic study on dimensions, causes and ameliorative strategies of poverty and marginalisation among the marine fisherfolk of India	Dr. C. Ramachandran
28.	SEE/PET/01	Impact of WTO regulations in Indian fisheries trade: a policy perspective	Dr. Shyam S. Salim
29.	SEE/RE/04	Total factor productivity analysis of marine Fisheries in India	Dr. N. Aswathy
30.	SEE/RE/05	Coastal rural indebtedness and impact of Micro Finance in Marine fisheries Sector	Dr. V.P. Vipin Kumar

Sponsored Projects

Sl.No.	Title of the Project	Name of PI	Name of the Funding Agency
1	Farming and pearl production in the black lip pearl oyster *Pinctada margaritifera*	Dr. K. S. Mohamed	MoES/CMLRE
2	Open sea floating cage farm for R&D in marine finfish and shellfish production	Dr. G. Syda Rao	MoA (DAHD&F)
3	Seed production in agricultural crops and fisheries	Dr. K. Madhu	ICAR
4	Application of micro organisms in agriculture and allied sectors (AMAAS): Microbial diversity and identification – fish microbes (NBAIM-Mau)	Dr. Imelda Joseph	ICAR Network (NBAIM-Mau)
5	Assessment of myctophid resources in the Arabian Sea and development of harvest and post harvest technologies	Dr. E. M. Abdussamad	MoES/CMLRE
6	Impact, adaptation and vulnerability of Indian Agriculture to climate change (II phase)	Dr. E. Vivekanandan	ICAR Network
7	Demonstration and transfer of technology of marine pearl culture *Pinctada fucata*	Dr. I. Jagadis	MoES, CMLRE
8	Fast track scheme: Characterization of novel antioxidants from red and brown seaweeds from Gulf of Mannar	Dr. Kajal Chakraborty	DST
9	Open sea cage culture demonstration farms in India	Dr. G. Syda Rao	NFDB
10	Application of microorganisms in agriculture and allied Sectors (AMAAS): Development of a library putative probionts from marine environment belonging to the genus *Pseudomonas, Micrococcus* and *Bacillus* for application in mariculture systems	Dr. K. K. Vijayan	ICAR Network (NBAIM-Mau)
11	Establishment and chararacterization of cell lines from selected marine food fish and ornamental fish	Dr. K. S. Sobhana	DBT
12	Development of shallow water grow-out techniques for the venerid clam, *Paphia malabarica* (Chemnitz) and the corbiculid clam, *Villorita cyprinoides* (Grey)	Dr. N. Suja (Dr. K.S. Muhammed Sci. Mentor)	DST (Women Scientists Scheme)
13	Assessment of fishery resources along the Indian continental slope and Central Indian Ocean	Dr. U. Ganga	MoES/CMLRE
14	Studies on marine mammals of Indian Exclusive Economic Zone and the contiguous seas (II phase)	Dr. E. Vivekanandan	MoES/CMLRE
15	Bioinventorisation of coral fishes of South India with special reference to threats and conservation measures	Smt. Rekha J. Nair	MoEF
16	An assessment of literacy, income and health status of fishers in India.	Dr. R. Sathiadhas	MoA (DAHD&F)
17	ICAR outreach activity on fish genetic stocks	Dr. P. C. Thomas	ICAR Outreach

Sl.No.	Title of the Project	Name of PI	Name of the Funding Agency
18	ICAR outreach activity on fish feeds Outreach	Dr. P.Vijayagopal	ICAR
19	ICAR outreach activity on nutrient profiling and evaluation of fish as a dietary component	Dr. Kajal Chakraborty	ICAR Outreach
20	Evaluation and development of green water technology for bioremediation in coastal aquaculture	Dr. Reeta Jayasankar	DBT
21	Development of cage of mariculture through numerical and physical modeling.	Dr. G. Syda Rao	MoES
22	EFC Memo Project Implementation Committee of Marine Fisheries.	Dr. E.Vivekanandan	DARE MoA
23	Satellite Telemetry Studies on Migration Patterns of Tunas in the Indian Seas (SATTUNA)	Dr. Prathibha Rohit	INCOIS
24	Flow of matter thorugh trophic levels and biogeochemical cycles in marine and estuarine ecosystems	Dr. Sujitha Thomas	MoES/OOIS/SIBER
25	Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach.	Dr. K.S. Mohamed	NAIP
26	A value chain on high value shellfishes from mariculture systems.	Dr.T.S.Velayudhan	NAIP
27	Export oriented marine value chain for farmed sea food production using Cobia through rural entrepreneurship.	Dr. G. Gopakumar	NAIP
28	Bio-prospecting of genes and allele mining for abiotic stress tolerance.	Dr. K. K.Vijayan	NAIP
29	Strategies to enhance adaptive capacity to climate change in vulnerable regions.	Dr.V.V. Singh	World Bank GEF NAIP
30	Developing, Commissioning, Operating and Managing Online System for NET/ARS- Prelim Examinations by ASRB/ICAR.	Dr. G. Syda Rao	NAIP
31	A value chain on oceanic tuna fisheries in Lakshadweep Sea.	Dr. E.V. Radhakrishnan	NAIP

Consultancy projects

Sl. No.	Title	Client
1	Impact assessment of multipurpose reef at Howa Beach, Kovalam, Thiruvananthapuram on fishery resources of the area	The Director, Dept. of Tourism, Park Avenue, Thiruvananthapuram
2	Monitoring chemical parameters of effluent and the hydro-biological conditions in the Arabian sea off Chitrapur (Phase-11)	M/s.MRPL, Mangalore
3	Setting up of modern library at RGCA, Sirkali	Project Director, RGCA, Sirkali, Tamil Nadu
4	Study on the use of Fly ash for manufacture of Artificial Reefs	Deputy manager (AUD), NTPC, Simhadri Thermal Power Plant, Visakhapatnam
5	Baseline data collection and monitoring for environment and social impact assessment for the development of Vizhinjam Port	Dr. Suparna Mulick, M/s Asian Consulting Engineers (Pvt.) Ltd., New Delhi-110 048
6	Consultancy on artificial reefs in inshore waters of two districts of Tamil Nadu	The Project Director IFAD assisted PTSLP TN Corpn. for development of women, 100 Anna Salai Rd, Guindy, Chennai
7	Marine EIA study for Kudankulam Nuclear Power Plant	M/s Alpha Marine Emergency Response Service Pvt.Ltd., 13, 2nd Floor, 1st Main Road , SBM Colony, Anand Nagar, Bangalore
8	Consultancy on artificial reefs in inshore waters of four districts of Tamil Nadu	The Project Director IFAD assisted PTSLP TN Corpn. for development of women, 100 Anna Salai Rd, Guindy, Chennai
9	Installation of artificial reefs in inshore waters of two villages in Kancheepuram District of Tamil Nadu	Commissioner of Fisheries, Dept. of fisheries, Govt. of TN
10	Rapid assessment of fishery resources of Vasishty river estuarine system and possible impact of intake and discharge of water from thermal power plant on it	NIO, Mumbai Regional Centre, 4 Bungalow, Versova, Andheri- (W) MUMBAI
11	Consultancy project on Marine Rapid EIA study and preparation of MEIA report for Sindya Power Generating Company Private Ltd.'s coastal thermal power project at Sirkazhi, TN	Vice President (Proj), Sindya Power Generating Company Private Ltd., 5th Floor, Pottipati Plaza, 77, Nungambakkam High Road, CHENNAI – 600 034.

Human Resource Development Cell

Training category	No. of programmes	No. of participants
Programmes conducted CMFRI for staff	31	243
Programmes conducted for outside participants	22	588
Total	**53**	**831**

Ph.D programme	No. of scholars
Under Cochin Univeristy of Science and Technology	21
Under Mangalore Univeristy	23
Total	**44**

HRD programmes attended by CMFRI Staff

Sl.No	Training Programme	Nos.	Place	Period
1	Training on environmental parameters, benthos and plankton	1	Vizhinjam RC of CMFRI	23 April to 3 May 2011
2	NACA/CMFRI Seminar 'Emerging issues in Asian Aquaculture'	101	CMFRI, Kochi	12 May 2011
3	Workshop on Reproductive dynamics and stock assessment of crustaceans	12	CMFRI, Kochi	18 to 23 July 2011
4	Data mining and GIS for decision support in agriculture	1	NAARM, Hyderabad	1to 12 Aug. 2011
5	Data analysis using SAS	1	UAS, Bangalore	8 to 13 Aug. 2011
6	Workshop on molecular sub typing of microbes using pulsed field Gel Electrophoresis	1	ICAR Research Complex Goa	20 to 24 Aug. 2011
7	Science administration and research management	2	Administration Staff College, Hyderabad	5 to 16 Sept. 2011
8	Multimedia digital content development and management	1	NAARM, Hyderabad	6 to 26 Sept. 2011
9	National training programme on Allele mining	1	IISR, Calicut	12 to 15 Sept. 2011
10	E-publishning training	16	CMFRI, Kochi	27 to 29 Sept. 2011
11	Training programme on Page maker, Coral draw and Photoshop	17	CMFRI, Kochi	14 to 24 Nov. 2011
12	Orientation training for newly recruited ARS scientists	6	CMFRI, Kochi	19 Dec. 2011 to 21 Jan. 2012
13	Cage culture	1	Karwar RC of CMFRI	1to 11 Jan. 2012
14	High resolution Image analysis for natural hazard assessment	1	IIRS, Dehradun	2 to 20 Jan. 2012
15	Innovative communication interventions for suitable agricultural development	1	IARI, New Delhi	18 Jan. to 7 Feb. 2012
16	Refresher course on agricultural research management	1	NAARM, Hyderabad	19 Jan. to 8 Feb. 2012
17	Training programme on cobia and pompano seed production, seaweed farming, propagation of soft corals	6	Mandapam RC of CMFRI	23 to 25 Jan. 2012
18	Project workshop on Resource damage assessment in marine fisheries: impact of selective fishing of juveniles and by catch and discards in trawl fisheries	12	CMFRI, Kochi	27 to 28 Jan. 2012

19	Training programme on MS Access	28	CMFRI, Kochi	1 to 8 Feb. 2012
20	Influence of environment on fisheries	10	CMFRI, Kochi	7 to 9 Feb. 2012
21	Marine cage fabrication and installation techniques	3	Veraval RC	7 to 9 Feb. 2012
22	Development of brood and genetic conservation	1	CIFE Mumbai	8 to 28 Feb. 2012
23	Identification and taxonomy of marine zooplankton	25	CMFRI, Kochi	13 to 17 Feb. 2012
24	Advanced models on fish stock assessment and biodiversity analysis	16	Madras RC of CMFRI	13 to 21 Feb. 2012
25	National training programme on 'Marine finfish seed production with special reference to Cobia and Pompano'	28	Mandapam RC of CMFRI	15 to 24 Feb. 2012
26	Training programme on Accreditation of Laboratories by National Accreditation Board of Labs, New Delhi	1	IIQM, Jaipur	26 to 29 March 2012
27	Better management practices in lobster farming in open sea cages	4	Veraval RC	22 Feb. to 13 March 2012
28	Introduction to biology and taxonomy of demersal finfishes	8	CMFRI, Kochi	23 to 25 Feb. 2012
29	Methodologies for fishery biological studies, fishery data analysis, fishery resources assessment and record keeping	11	Veraval RC of CMFRI	23 to 29 Feb. 2012
30	Training programme on advanced models on fish stock assessment and biodiversity analysis	2	Madras RC of CMFRI	12 to 20 March 2012
31	Identification of marine finfishes and shellfishes	31	Visakhapatnam RC of CMFRI	19 to 25 March 2012
32	Marine finfish breeding and seed production technology	3	Mandapam RC of CMFRI	15 to 24 Feb. 2012
	Total	**243**		

HRD Programmes conducted for outside participants

Sl. No	Topic	Place	Participants	Period
1	Training course on strengthening fisheries data collection and stock assessment for BOBP-IGO member countries	CMFRI, Kochi	13 (From BOBP member countries)	25 April to 7 May 2011
2	NACA/CMFRI seminar 'Emerging issues in Asian Aquaculture'	CMFRI, Kochi	34	12 May 2011
3	Training on culture of shrimp and seaweed for students from CIFE, Mmbai	Mandapam RC of CMFRI	15	20 June to 2 July 2011
4	Training on marine ornamental fish breeding	CMFRI, Kochi	5	3 to 9 Aug. 2011
5	Training on mariculture for students from CIFE, Mmbai	Mandapam RC of CMFRI	14	7 to 12 Aug. 2011
6	Training programme on aquaculture	CMFRI, Kochi	15	10 to 19 Oct. 2011
7	Training on advanced techniques in ornamental fish keeping and breeding	Vizhinjam RC of CMFRI	20	22 Nov. to 1 Dec. 2011
8	One day demonstration cum training programme on lobster fattening for farmers	Vizhinjam RC of CMFRI	25	4 Feb. 2012
9	Marine cagae fabrication and installation techniques	Veraval RC of CMFRI	35	7 to 9 Feb. 2012
10	National training programme on marine finfish seed production with special reference to cobia and pompano	Mandapam RC of CMFRI	11	15 to 24 Feb. 2012
11	Better management practices in lobster farming in open sea cages	Veraval RC of CMFRI	25	22 Feb. to 13 March 2012
12	Introduction to biology and taxonomy of demersal finfishes	CMFRI, Kochi	7	23-25 Feb. 2012
13	*Etroplus* breeding and farming	CMFRI Kochi	40	21- 25 Feb. 2012
14	Methodologies for fishery biological studies, fishery data analysis, fishery resources assessment and record keeping	Veraval RC of CMFRI	20	23 to 29 Feb. 2012
15	Training in sea farming avenues and cage aquaculture to cope with climate variability	Kanyakumari FC of CMFRI.	25	27-28 Feb. 2012
16	Open sea cage culture for farmers	Karwar RC of CMFRI	18	27 Feb. to 3 March 2012
17	Open sea cage culture for farmers	Karwar RC of CMFRI	17	5 to 10 March 2012
18	Open sea cage culture of finfishes	Visakhapatnam RC of CMFRI	27	12 to18 March 2012
19	High density fresh water fish culture in abandoned granite quarries	Kothamangalam, Ernakulam District Conducted by KVK	85	16 March 2012
20	Open sea cage culture	Karwar RC of CMFRI	12	19 to 24 March 2012
21	Identification of marine finfishes and shellfishes	Visakhapatnam	4	19 to 25 March 2012
22	Training on pearl spot farming	KVK Narackal	120	20 & 21 March 2012
	Total		**588**	

Programmes Organised

Institute Management Committee (IMC)

The 72nd IMC meeting was held on 24.11.2011 at CMFRI Headquarters. Review of action taken on the items considered during the previous meeting held on 26.03.2011 at CMFRI was done. As per the proposal submitted to the IMC of CMFRI for nomination of members to the Institute Grievance Committee, the Grievance Committee of CMFRI has been re-nominated. The proposal for recognition of NUSI Wockhardt Hospital Goa for treatment to the Staff and their family members at Karwar RC has been sent to the Council for approval. On the basis of the recommendation of the IMC, the Council has approved the expenditure incurred on security service of CMFRI. The IMC placed on record recommendation for procurement/ construction of 13.50 OAL Steel Body Boat from the M/s Goa Shipyard Ltd. The IMC recommended for pre mature condemnation of Mahindra& Mahindra Jeep of KVK of CMFRI, Narakal, Ernakulum. Expenditure of the amount allotted under Plan and Non-Plan 'Works' for the financial year 2009-10 was reviewed. Expenditure on various maintenance works at Headquarters and Regional/ Research Centres under Plan and Non-Plan 'Works' for the financial year 2010-11 was also reviewed.

Research Advisory Committee (RAC)

The 16th RAC meeting of CMFRI was held at CMFRI, Cochin on 26th and 27th March, 2012. The meeting was chaired by the RAC Chairman, Dr. M.V. Gupta, former ADG, World Fish Centre.

The meeting commenced on 26.03.12 at 10.30 am. Dr. G. Syda Rao, Director, CMFRI formally welcomed the Chairman and members of the RAC. He made a comprehensive presentation on the activities and achievements of the Institute during the year 2011-12. The following recommendations were made by the RAC:

- CMFRI should analyse the vast amount of historic data available with the Institute and come out with inferences and management solutions.
- Fishermen workshops, meeting and consultations should be held regularly.
- Anthropogenic impacts of coastal developments on fish resources may be studied in detail.
- Performance of Marine Protected Areas (MPAs) may be assessed by the CMFRI.
- Socio-economic evaluation of cage culture of different species may be worked out.
- To revive taxonomic expertise on marine organisms, CMFRI may conduct series of training programmes.
- Training may be given to scientists in global Centres of Excellence.
- Impact of CMFRI research on stakeholders at different levels may be studied.
- In mariculture, the available seed production technologies may be strengthened, and new species may be attempted.
- Policy related research is important in capture fisheries as well as mariculture.
- Since Terms of Reference for marine EIA is weak, the CMFRI may make attempts to devise ToR with special reference to marine fisheries and mariculture. Attempts may be made to fill the vacancies of Scientists' posts.

Institute Research Council (IRC)

The 18th Institute Research Council (IRC) meeting was held in Institute Headquarters at Kochi from 9th May - 13th May, 2011, under the chairmanship of Dr. G. Syda Rao, Director, CMFRI. The Heads of Divisions, Principal Investigators and Co-PIs from Headquarters, all Regional and Research Centers attended the meeting and the progress under the inhouse of the Institute was critically evaluated. The new projects presented by the PIs were also evaluated and recommended by IRC for implementation during 2011- 2012.

Workshops

- Workshop for all project associates of MOES funded SIBER project at Mangalore RC of CMFRI on 7th Jun 2011
- "Stock Assessment of Tunas" at CMFRI, Kochi during 25th and 30th July 2011
- "Biodiversity valuation of Marine ecosystem of the southwest coast of India at CMFRI, Kochi during 16th and 18th August, 2011
- Hindi Workshop at Madras RC of CMFRI, Chennai on 20th August 2011
- Workshop on the use of Hindi in administrative work and scientific work at CMFRI, Visakhapatanam on 15th September 2011

- Hindi Pakhwada at Mumbai RC of CMFRI from 14th to 29th September 2011
- "Marine Fisheries Census 2010 data validation" for the State of Kerala at CMFRI, Cochin during 27th to 29th October 2011
- "Marine Fisheries Census 2010 data validation" for Karnataka and Goa at Mangalore RC, during 28th to 29th October 2011
- "Marine Fisheries Census 2010 data validation"for Tamil Nadu and Puducherry at Mandapam RC from 28th October 2011 to 29th October 2011 and at Chennai RC from 31st October 2011 to 1st November 2011 respectively
- "Marine Fisheries Census 2010 data validation" for the States of Maharashtra and Gujarat at Mumbai Research Centre, Mumbai from 31st October 2011 to 1st November 2011 and at Veraval RC from 3rd to 4th November 2011 respectively
- "Marine Fisheries Census 2010 data validation" for the States of West Bengal, Odhisha and Andhra Pradesh at Visakhapatnam RC, Visakhapatnam from 8th to 12th November 2011
- "Completion workshop on Stock Assessment of Tunas and preparation of scientific reports" was organized at CMFRI, Kochi during 28th to 30th November 2011
- "Biodiversity valuation of Marine ecosystem of the southwest coast of India at CMFRI, Kochi during 27th to 30th December 2011
- Working Group Meeting at Mumbai RC of CMFRI organized for the 'Development of competency based curricula on marine fisheries' in collaboration with PSSCIVE, Bhopal from 26th to 30th December 2011
- Hindi workshop for stakeholders on centre's activities and use of mobile in fisheries i.e. m-Krishi Fisheries in local language and Hindi at Mumbai RC of CMFRI on 3rd February 2012
- Workshop on Marine environment and fishery fluctuations at CMFRI, Kochi during 7th to 9th February 2012
- Write Shop on Indigenous Technical Knowledge (ITK) of Fisherfolk on climate change at the Mangalore RC of CMFRI, during 22nd to 24th March 2012.

Training programmes

- Regional Training Course on "Strengthening Fisheries Data Collection and Stock Assessment" jointly organized by CMFRI and Fishery Survey of India under funding from the Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO) at CMFRI Kochi during 25th April to 7th May 2011.
- Training programme for 2nd year M.F.Sc students of Fishery Resource Assessment and Aquatic Environment Management division CIFE Mumbai during 20th June to 2nd July 2011.
- Training programme for 2nd year M.F.Sc. students, Aquaculture division CIFE Mumbai during 7th to 12th August 2011.
- Training programme on Marine ornamental fish breeding at Vizhinjam RC of CMFRI during 3rd to 5th August 2011
- Training programme on plankton and benthos identification and analysis at Vizhinjam RC of CMFRI during 8th to12th August 2011
- National training on Advanced Techniques in marine ornamental fish keeping and breeding at Vizhinjam RC of CMFRI during 22nd November to 1st December 2011
- Training Programme on Biology and taxonomy of Demersal finfishes for the ARS probationers during 1st to 4th January 2012
- Training programme for Lakshadweep fishermen at Karwar Research of CMFRI during 4th to 7th January 2012
- Training programme on spat production and hatchery rearing of edible oyster at KVK Njarakkal during 10th to 30th January2012
- Demonstration cum training programme on 'lobster fattening' during the "ATMA Scheme - Exposure visit" of fish farmers from Kollam District, Kerala at Vizhinjam RC of CMFRI on 4th February 2012
- Training on marine zooplankton identification at CMFRI, Kochi during 13th to 17th February, 2012
- All India Training programme on Marine Finfish seed production with special reference to Cobia and Pompano at Mandapam RC of CMFRI during 15th to 24th February 2012
- Training Programme on Introduction to biology and taxonomy of Demersal finfishes at CMFRI, Kochi during 23rd to 25th February 2012
- Training programme for fishermen on Open Sea Cage Culture of Marine finfish and shellfish at Karwar RC of CMFRI during 27th February to 5th March 2012
- Training programme on Sea Farming and Cage Aquaculture to cope up with climate variability at Kanyakumari during 8th to 9th March 2012
- Training programme on Cage farming of marine finfish and shellfish at Karwar RC of CMFRI during 19th to 24th March 2012
- Training programme on Advance models on fish stock assessment and biodiversity analaysis at Chennai RC of CMFRI, during 12th to 20th March 2012

- Under consultancy programmes (2 for the Tamil Nadu Corporation for Development of Women and one for the Tamil Nadu State Fisheries Department) on Installation of Artificial Reefs in the coastal waters of Tamil Nadu a series of Fishermen Meets on Artificial reefs were organized in the following coastal villages:

  Goonankuppam Village, Thiruvallur District (13th July 2011), Kovalam Village, Kancheepuram District (14th July 2011), 2 villages in Kanyakumari District (7th and 8th February 2012), 2 villages in Nagapattinam District (9th and 10th February 2012), 2 villages in Cuddalore District (22nd and 23rd February 2012), 2 villages in Villupuram District (24th and 25th February 2012).

Events

Painting competition for children aged between 5-20 years as a part of creating awareness in coastal communities on the importance of 'Coastal Environment Protection' along with Elamkunnapuzha Grama Panchayat during 22nd March 2012.

Participation in Exhibitions

- Exposition in connection with the International Convention on 'Emerging issues in Asian Aquaculture' organized by 'Network of Aquaculture Countries of Asia' (NACA) at Ramada International Resort at Kochi during 9th to 12th May, 2011.
- 'ICAR - CII Industry Meet - 2011' at NASC Complex, New Delhi on 23rd May, 2011.
- Public Information Campaign Exhibition organised by Press Information Bureau, Cochin and other media units under the Union Ministry of Information & Broadcasting at Thondiyil, Peravoor, Kannur District during 8th to 10th June 2011.
- 'Bharath Nirman-2011' exhibition at Mannar, Aleppey during 21st to 23rd August 2011.
- 'Haritholsavam' exhibition at Maradu during 3rd to 7th September, 2011.
- 'Haritholsavam' exhibition at Agricultural College, Vellayani during 19th to 24th September, 2011
- International Conference–cum-exhibition 'Food 3600' at Hyderabad International Convention Centre during 20th to 22nd November, 2011.
- "Eighth Symposium on Diseases in Asian Aquaculture" Exhibition organized by the Asian Fisheries Society and College of Fisheries at Mangalore during 21st to 25th November, 2011.
- 9th Indian Fisheries Forum Exhibition at Chennai during 19th to 23rd December 2011.
- 'Karshikamela' exhibition at Thodupuzha during 26th December 2011 to 1st January, 2012.
- 'Science Expo' at Kottayam during 28th to 31st January, 2012.
- 'Astral 2012' at Alappuzha during 2nd to 4th February, 2012.
- 'Aquashow' at Jawaharlal Nehru Stadium, Kochi during 9th to 13th February, 2012.
- Pusa Krishi Vigyan Mela at IARI, New Delhi during 1st to 3rd March, 2012.

Library and Documentation

CMFRI library provides access to print, electronic and digital library resources in most user friendly manner. During the year Library subscribed 65 national and international journals including online versions.

Services provided

1. **OPAC** - Details of books, journals, current periodicals, reports, proceedings, theses and other publications available in the library can be searched through the Online Public Access Catalogue (OPAC) hosted in the Institute website.

2. **Online journals & Databases** - Online journals and databases are made available to HQs, Regional and Research Centres through Institute website. ASFA Online Database covers records from 1971 onwards and Wiley online journals from Vol.1 onwards. Springer and Elsevier journals are made available through CeRA.

3. Computerised circulation of books & journals continued to the members of library.

4. **Digital Library** - CMFRI Digital Library System houses all electronic publications and informations available in the Library. It provides access to Databases, CD-ROMs, Electronic Journals, holdings of journals, current periodicals, CMFRI Theses and Dissertations and other CMFRI Publications.

5. **Access to CERA** - Access to more than 3000 electronic journals on agriculture and allied subjects is made available to CMFRI HQs and RCs through Consortium for e-Resources in Agriculture, under the NAIP, ICAR project.

6. **CMFRI Digital Library Information Service** - provides the latest information in the field of marine research and fisheries to all the scientists individually by email.

7. **Current Awareness Service** - 'Current Awareness Service', the monthly content page service for selected journals made available in digital format and can be accessed at HQS and Regional/ Research Centres from Institute website.

8. **Exchange of Institute Publications** - The library maintains an exchange relationship with various National and International Research Institutes, Universities and other organizations for Institute publications and receives 400 titles in exchange/complementary. The library maintains a free mailing list for free distribution of Institute publications.

9. **Eprints@CMFRI** - 'Eprints@CMFRI' the Open Access Institutional Repository of the Institute provides free access to all the published scientific papers of CMFRI staff in pdf format. Users all over the world can download the articles from 'Eprints@CMFRI' in Institute website.

10. Reference facility and reprographic services provided to the users.

CMFRI Publications released during 2011-12

- Indian Journal of Fisheries :Vol. 58 Nos. 1-4, 2011
- Marine Fisheries Information Service : Nos. 205 to 208
- Newsletter : Nos. 129-131
- Special Publication : Nos. 105 to 107
- Annual Report : 2010-11
- Book : Carangids of India
- Book : Marine Fish Marketing in India
- Book Fisheries Glossary English - Hindi

CMFRI Marine Biodiversity Museum

The Designated National Repository Museum of CMFRI, recognized by the Government of India is authorised to keep in safe custody, specimens of different categories of biological material. Currently the museum houses specimens of about 1600 species belonging to different groups of marine organisms.

New additions to the Museum

Soft corals

1. *Lobophytum pauciflorum* (Ehrenberg, 1834)
2. *Cladiella australis* (Macfadyen, 1936)

Shrimps

1. *Parastylodactylus sulcatus* (sp. nov.)
2. *Sicyonia paraJaponica* (Crosnier,2003)
3. *Acanthephyra sanguinea* (Woodmason & Alcock,1892)
4. *Plesionika adensameri* (Balss,1914)

Crabs

1. *Pilumnus vespertilio* (Fabricius,1793)
2. *Daldorfia horrida* (Linnaeus,1758)
3. *Hyastenus diacanthus* (De Hann,1835)
4. *Liagora rubromaculata* (De Hann,1835)
5. *Macrophthalmus (Venitus) latreillei* (Desmarest,1822)
6. *Dotilla sp.*

Mollusc

1. *Kalinga ornata* (Alder J. & Hancock A.,1864)

Fishes

1. *Lalmohania velutina* (Hutchins,1994)
2. *Lagocephalus scleratus* (Gmelin,1789)
3. *Rhinobatos variegates* (Nair & Lalmohan,1973)
4. *Symphysanodon xanthopterygion* (Anderson & Bineesh,2011)
5. *Chelidoperca latifasciatum* (sp. nov.)
6. *Aetobatus narinari* (Euphrasen, 1790)
7. *Carangoides hedlandensis* (Whitley, 1934)
8. *Antennarius pictus* (Shaw, 1794)
9. *Acreichthys tomentosus* (Linnaeus, 1758)
10. *Equulites leuciscus* (Günther, 1860)
11. *Secutor ruconius* (Hamilton, 1822)
12. *Carangoides orthogrammus* (Jordan & Gilbert, 1882)
13. *Abalistes stellaris* (Bloch & Schneider, 1801)
14. *Parupeneus forsskali* (Fourmanoir & Guézé, 1976)
15. *Parupeneus heptacanthus* (Lacepède, 1802)
16. *Torquigener hypselogeneion* (Bleeker, 1852)
17. *Neotrygon kuhlii* (Müller & Henle, 1841)
18. *Halichoeres zeylonicus* (Bennett, 1833)
19. *Sphyraena flavicauda* (Rüppell, 1838)
20. *Nemipterus zysron* (Bleeker, 1857)

Dr. Barry Russell, Senior Research Fellow and Curator, Emeritus, Museum & Art Gallery of the Northern Territory, Australia visiting CMFRI Museum at Kochi on 4th November, 2011.

Dr. Usha Varanasi, Distinguished Scholar in Residence at University of Washington's College of the Environment and former Director, National Marine Fisheries Service, Northwest Fisheries Science Centre, USA visiting CMFRI Museum at Kochi on 24th January, 2012.

A section of 1350 students who visited the CMFRI Museum at Headquarters on the Institute Foundation Day, 3rd February 2012.

21. *Uropterygius concolor* (Rüppell, 1838)
22. *Neoglyphidodon melas* (Cuvier, 1830)
23. *Bolbomet opon muricatum* (Valenciennes, 1840)
24. *Aulostomus chinensis* (Linnaeus, 1766)
25. *Chaetodon gardineri (*Norman)
26. *Johnius amblycephalus* (Bleeker, 1855)
27. *Apogonighthyoides silasi* (Jordan & Thompson,1914)
28. *Colletteichthys flavipinnis* (sp. nov.)
29. *Hyporthodus octofasciatus* (Griffin,1926)
30. *Centroberyx rubricaudus* (Liu & Shen,1985)

Visitors to the Designated National Repository Museum

- A total of 7,528 people from 22 States and Union Territories of the country visited the Museum during the period under report.
- Students constituted 88% of the total visitors indicating the significant role the Museum plays in education.
- Students were from 17 States and Union Territories of the country;136 educational institutions from Kerala, 25 from Tamil Nadu, 6 from Maharashtra, 3 from Karnataka, 2 each from Odisha, Bihar, Andhra Pradesh, Gujarat, one each from Jammu & Kashmir, Uttarakhand, Himachal Pradesh, Punjab, Madhya Pradesh, Tripura, West Bengal, Lakshadweep and Andaman & Nicobar Islands.
- Visitors also included 435 personnel belonging to 87 organisations from 14 States and Union Territories of the country and 6 neibhouring countries.

Krishi Vigyan Kendra

Front Line Demonstrations (FLDs)

Frontline demonstration is an important programme of KVK wherein perfected and time tested technologies are demonstrated in farmer's fields for its popularization and percolation among farming community. This programme is based on the principle; seeing is believing. During the year 2011-12, KVK (Ernakulam) has conducted 12 FLDs.

Three demonstration units of Soviet Chinchilla rabbits were set up in farmers fields at Kumbalangi and Thevara. Soviet Chinchilla rabbits are known for its meat quality and growth rate. Another FLD was to demonstrate the production potential of Japanese quails wherein 7 demonstration units each comprising of 50 birds were set up in farmers fields of Kumbalangi and Thevara. Frontline demonstration of revised deworming schedule in calves was conducted at 10 locations in Kumbalangi, Thevara and Vypeen. Revised de-worming schedule in calves is for effective management of Toxocarosis in calves, which affect its growth rate.

KVK (Ernakulam) promotes roof top vegetable cultivation with a view to promote self sufficiency in safe vegetable production. Total of 10 demonstration units were set up in the villages of Kumbalangi, Chellanam and also in Edappalli block. Apart from this, total of 8 trainings on the roof top vegetable cultivation were conducted.

There is huge demand for the seeds of pearlspot, the state fish of Kerala. In addition to producing seeds in the hatcheries, KVK has also taken steps to collect seeds from wild. In this connection, an FLD on demonstration of pearlspot seed bank by mobilizing women groups was initiated in Vypeen island. Fishermen and women were educated on the importance of maintaining the seed bank and arrangements were made to stock the collected fingerlings at KVK. This successful method is promising as it provides additional income for the women groups in the area.

There are number of farmers in the eastern parts of the district interested in freshwater fish culture, whereas availability of good quality seeds is a major constraint. With a view to solve the problem of seed scarcity, an FLD on production of carp seeds using portable carp hatchery was initiated in a farmer's field at Kothamangalam. The portable hatchery has a capacity of producing 5 lakh seeds per season.

Upland paddy cultivation is getting wide popularity in the district in recent times. In this connection, KVK has introduced a new paddy variety Sampada, released from Kerala Agricultural University as part of one of the FLDs. The demonstrations recorded a productivity of 4.85 mt/ha.

Tender coconut has good demand, sale of which is one of the popular income generating activity among the marginal farmers of the coastal districts. In order to improve their income through value addition of the tender nut, a programme on "Snowball tender coconut production and marketing" has been implemented by the KVK. Selected SHG group Dhanalakshmi, Narakkal was trained on production, label designing, packing and marketing of snow ball nuts.

Considerable amount of the labour cost in vegetable cultivation is accounted for weeding. In order to tackle this problem, demonstration of

Farmers field school on Scientific Banana cultivation

Farmer's visit to KVK farm, Thevara

Fish pickle being packed at KVK for test marketing

Frontline demonstration of new paddy variety-Sampada

Manual milking machine being evaluated in farmers field

Organically grown cabbage in KVK farm

Organically grown Carrot at KVK farm

weed management using plastic mulching in vegetable was conducted at three locations in Thevara and Mookkanoor

The coconut production is getting reduced in Kerala. There is a need to introduce newer varieties having high production. In this regard, KVK has taken up FLD on cultivation of high yielding coconut variety Kerasree at Kuzhippally, Ayyampally, Cherai and Edavanakad.

On Farm Testings (OFT)

On farm testing is meant for assessing the performance of lab tested technologies in farmers field and also to refine the technologies to suit specific locations. During the year 2011-12, KVK has done 9 nos. of OFTs. The extent of drudgery reduction using single cow milking machine was assessed in a farmer's field at Muvattupuzha. The performance assessment of goat kids under supplementation with yeast and commercial probiotics was carried out at Edavanakad, Cherai and Mookkanoor.

Farmers field trials on the performance of cabbage varieties NS-163 and NS-183 were carried out at 8 locations in Mookanoor, Aluva and Kalamassery. It was found that NS-183 was superior in yield and head size whereas NS-163 was better in terms of head compactness.

Cultivation of vegetables in rain shelter was conducted at 4 locations, *viz.,* Kangarappadi, Kumbalangi, Chellanam and Thevara. Growth of crops inside the protected structure was much better compared to the vegetables grown in open. This was because of the additive effect of UV stabilized polysheet by harnessing more visible light and also due to protection from rain. The diffused light inside the rain shelter helped in producing more photosynthates.

On farm testing of cage culture of fin fishes in brackishwater was done at Pallipuram. Pearlspot (*Etroplus suratensis*) was selected as the candidate species for the test. Five hundred numbers of pearlspot fingerlings of 5 cm to 8 cm size were stocked in each cage units. The OFT on testing of cage culture of freshwater fishes in unutilized fresh water system was done in a granite quarry at Kothamangalam. Here also pearlspot was selected as candidate fish.

This KVK has introduced maize for the first time in Kerala. In order to assess the performance of maize in farmers field and to assess their response to this new crop, on farm testing of maize variety Pratap was conducted at 4 locations *viz*., Karimnaloor, Mookannur, Kumbalangi and Chellanam. In order to promote organic cococnut cultivation through in-situ production of manure, an on farm testing was conducted at 5 locations on production of organic manure in coconut garden. Assessment of effectiveness of neem cake and GNC mixture in urban and urban fringe farm was done at thevara.

Training programmes

During the report period, KVK has organized 34 training programmes on various topics wherein 1300 farmers participated. In addition, a short course on Horticultural nursery management was organized exclusively for 2 Self help women groups. Exposure visits to KVK farm was promoted during 2011-12, wherein more than 500 farmers visited and interacted with the scientists. Total of seven method demonstrations on Panchagavya preparation were conducted at different parts of the district during which 350 farmers got benefitted.

Animal breeding unit at Thevara campus

A model rabbit breeding unit was commenced at Thevara campus of KVK. Breeder animals were brought from Southern Regional Research Centre of Central Sheep and Wool Research Institute (ICAR), Mannavannur, Kodaikkanal. There are 6 female and 2 male breeder rabbits of Soviet Chinchilla Breed at the unit. It is envisaged to further multiply the pure breeds in farmer's fields.

Animal husbundry demonstration units

In order to demonstrate the production potential and other advantages of Japanese quail, a demonstration unit comprising of 50 birds was initiated at Thevara campus. In order to popularize cage rearing of Athulya breed poultry for egg purpose, a demonstration unit was set up at Thevara campus. Demonstration of *Azolla* production, which is a good protein source for poultry as well as animals was also set up at Thevara.

Vegetable seedling production

Seed germination percentage in farmer's field is less due to poor management practices. In order to tackle this problem, KVK has initiated growing seedlings and supplying at transplanting stage. Protray method of seedling raising was followed where the pest and disease incidence is minimum. A green house and net house facilities were created for this purpose.

Organic seed production cum demonstration farm

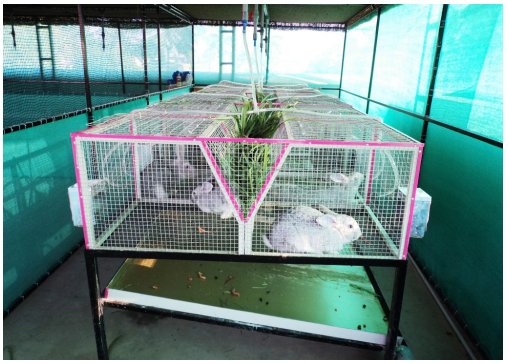
An organic vegetable seed production cum demonstration farm was established at Thevara campus. The land which was marshy initially was converted into productive land by filling soil and constructing sufficient drainage channels. Scientifically managed organic vegetable demonstration farm attracted many farmers to the campus. Coriander, palak, cowpea, brinjal, tomato, okra, chilly, maize, baby corn, sweet corn, carrot, raddish, cluster bean, capsicum, French bean, cabbage, cauliflower and amaranthus were grown in organic mode. Crop diary is maintained for compiling the organic farming experiences. The wastes from animal and poultry units are used as manure in this farm.

Farmers field school

A Farmer field school of 7 weeks duration on small scale cage culture of brackish water candidate fishes was conducted at Pallipuram. Fourty fish farmers from various places in Ernakulam district participated in this field school conducted during 24.01.2012 to 23.03.2012. The programme was inaugurated by Nayarambalam Grama Panchayath President Smt. Taji Roy. Scientists of KVK and CMFRI led the classes and practical sessions.

Another farmer's field school on Integrated crop management in banana was held at Kothamangalam with the participation of 47 progressive banana farmers. The seven week long programme was inaugurated by Dr. Shinoj Subramannian, Programme Coordinator/ Sr. Scientist of the KVK. The Standing committee chairperson of Kothamangalam Municipality Shri. V.V. Kurien was the guest of honour. Scientists of KVK led theory and practical sessions on various topics of banana cultivation right from land preparation to harvesting.

Organically grown cowpea at KVK farm


Rabbit breeding uni at Thevara


Rainshelter cultivation of Cauliflower in farmers field


Short term course on horticultural nursery management for women groups

Students participatory farming at FISAT Engineering college, Angamaly

Programme for students

A training for the students of Govt. Vocational Higher Secondary School, Narakkal was conducted wherein 54 students were trained on the technology of making different value added products from fish. In addition, students were educated on the entrepreneurship opportunities in fishery value addition. In another programme a student participatory farming was done at FISAT Engineering College, Angamaly wherein cool season vegetables like cabbage and cauliflower were grown, harvested and marketed by the students. In order to inculcate interest towards agriculture among students and younger generation, exposure visits were also arranged exclusively for students to KVK farm. More than 150 students visited the farm during November 2011.

Establishment of market linkages and test marketing of value added products

In order to promote entrepreneurship among fish product manufacturing Self help groups (SHGs) in the district, KVK established forward linkages with various product marketing agencies and backward linkages with raw fish suppliers. SHGs were trained on Good manufacturing practices (GMP) and products were test marketed to improve their confidence level. In one such novel attempt, fish pickle is being marketed by M/s Cochin Industries, Palliport at M/s Kannan Departmental Store, Coimbatore.

Soil health camps

Five soil health camps were conducted at Mookannor, Kothamangalam, Pallipuram, Pampakuda and Mazhuvannor panchayats. Nearly 200 farmers attended the programme. Soil health camps were conducted to make awareness among farmers regarding the importance of soil testing. Practical sessions were conducted on soil sampling procedure. The basic objective of soil health camp is to educate farmers on the economic use of fertilizers and better soil management practices for increasing the crop production.

Radio programmes

A documentary on Krishi Vigyan Kendra was broadcasted on 26-07-201 by AIR, Kochi. Radio talk on Horticulture demonstration farm at KVK-Thevara campus was broadcasted by AIR, Kochi on 09-08-2011. A Radio programme on High density planting of banana was broadcasted by AIR, Kochi on 06-10-2011 and 11-12-2011.

Scientific Advisory Committee meeting

The Scientific Advisory Committee Meeting of the KVK 2011-12 was conducted on 21st June, 2011 at CMFRI, Kochi. Dr. S. Prabhukumar, Zonal Project Director (Zone VIII) inaugurated the meeting. Dr. G. Syda Rao, Director, CMFRI presided over. Fisheries and Urban Horticulture were Identified as the flagship programmes of KVK (Ernakulam) during this meeting.

Vegetable Seedling production at KVK campus

Recognition/Honours

Dr. Shinoj Subramannian, Programme Co-ordinator has been nominated as member of the committee constituted by Govt. of Karnataka, Department of Horticulture to inspect and certify Palm oil mills in Karnataka.

Appointments

Dr. Shinoj Subramannian joined as Programme Co-ordinator/Sr. Scientist on 25th April 2011 and taken over the charge of KVK on 11th May 2011.

Shri.Vikas P.A joined as Subject Matter Specialist (Fisheries) on 7th December 2011.

Trainings attended by KVK Staff

- Shri. B. Sursh Kumar attended National Workshop for dissemination of horticultural technologies through KVK personnel during 18th to 19th January 2012
- Shri. P.A. Vikas attended Orientation Programme on Technology Assessment, Refinement and Demonstration at KVK Gadag in Karnataka during 14th to 18th February 2012
- Shri. Shoji Joy Edison attended Training on "Agriculture Project Planning and Management" at MANAGE during 27th to 1st June 2011
- Shri. F. Pushparaj Anjelo attended Workshop on portable carp hatchery held at CIFA during 11th - 13th July 2011
- Dr. K. Smita Sivadassan attended training programme on "Methods and techniques of fodder cultivation for augmenting livestock production" at TANUVAS, Chennai during 22nd to 23rd September 2011

Official Language Implementation

Ensurance of bilingualisation and targets of correspondence

During the year cent percent bilingual issue of Section 3(3) documents (1451), reply of letters received in Hindi (518) and target of Hindi correspondence (73.7% against the target of 55%) were ensured.

Under bilingualization of stationery items during the year 32 name plates, 18 rubber stamps, 56 Museum labels and labels of Hatchery, 4 Plaques; 2 Announcements; 2 Invitation cards; 52 Identity cards of Staff Members, Pensioners and Research Fellows were renewed; 6 charts; 64 Certificates of Hindi Chethana Mas and KVK Trainings were prepared. Bilingual standard drafts were prepared and issued to Vizhinjam Research Centre.

Parliamentary Committee visit at Mandapam RC

Official Language Implementation Committee meetings

The 87th, 88th, 89th and 90th meetings of Official Language Implementation Committee of the Institute were held on 25.06.2011, 29.09.2011, 30.12.2011 and March, 2012 respectively.

Review of Official Language activities of outstations

The Official Language implementation activities of all Regional and Research Centres were reviewed and suggestions were given for improvement.

Parliamentary Committee inspection

Mandapam Regional Centre

The Second Sub Committee of the Committee of Parliament on Official Language inspected the Official language implementation activities of Mandapam Regional Centre of CMFRI, Mandapam Camp on 09.05.2011.

Headquarters Cochin

The Second Sub Committee of the Committee of Parliament on Official Language inspected the Official Language implementation activities of CMFRI Headquarters, Cochin on 29th October, 2011. The inspection meeting was chaired by Dr. Prasanna Kumar Patasani, MP (Lok Sabha). Shri Y.P.Trivedi, MP (Rajya Sabha), Shri Kishanbhai V. Patel, MP (Lok Sabha); Dr. L.R. Yadav, Officiating Secretary, Dr. S.P.Shukla, Under Secretary, Shri G.S..Rawat, Hindi Officer and Shri Rajesh Jha, Reporter of the Committee Secretariate were present.

A view of Parliamentary Committee meeting at CMFRI Cochin

Inspection by Department of Official Language

Shri M. Vijayakumar, Assistant Director (Impl.), Hindi Implementation Office (S.W.), Department of Official Language, M/o Home Affairs, Cochin inspected the Official Language implementation activities of CMFRI Headquarters, Cochin on 25.10.2011.

Inspection of Centres

- Director, CMFRI inspected the Official Language implementation activities of Mumbai Research Centre on 19.05.2011 and 11.08.2011.
- Shri Rakesh Kumar, Chief Administrative Officer inspected the Official Language implementation activities of Veraval Regional Centre on 08.08.2011, Mumbai Research Centre on 10.08.2011 and Tuticorin Research Centre on 14.09.2011.
- Smt. Sheela P. J.,Assistant Director (OL) inspected the Official Language implementation activities of Mandapam Regional Centre on 07.05.2011.

- Smt. E.K. Uma and Smt. E.Sasikala, Technical Officers of CMFRI, Cochin inspected the Official Language implementation activities of Karwar Research Centre on 03.08.2011.
- Dr. Madan Mohan, ADG (Fy.) and Shri Harish Chandra Joshi, Director (OL), ICAR, New Delhi inspected the Official Language implementation activities of Veraval Regional Centre on 28.08.2011.
- Shri Manoj Kumar, Technical Officer (Hindi), ICAR, New Delhi inspected the Official Language implementation activities of Madras Research Centre on 20.08.2011.

HRD programmes

Hindi Workshops

During the year total 6 Hindi Workshops were conducted with a view to encourage the staff to work in Hindi with out hesitation.

- Hindi workshop at Tuticorin Research Centre on 23rd June 2011
- Hindi workshop at Calicut Research Centre on 30th June 2011
- Hindi workshop at Karwar Research Centre (Unicode) on 03rd August 2011
- Hindi workshop at Visakhapatnam Regional Centre in 15th September 2011
- Two Hindi workshops were conducted at Headquarters, Cochin on 15th and 17th December 2011 and 19th and 20th March 2012 (Unicode)
- Hindi workshop at Mangalore Research Centre (Unicode) on 29th February 2012.

Chief Guest of Hindi 'Chethana Mas' celebration Dr. S. Sasidharan, HOD, Hindi Dept., CUSAT

'A word a day' Programme

Under 'A word a day' programme around 278 Hindi words with English equivalents were displayed on display board and circulated among staff members of Headquarters and Outstations.

Hindi 'Chethana Mas' celebration

Hindi 'Chethana Mas' was observed at CMFRI Headquarters, Cochin from 1st to 30th September, 2011 with various competitions / programmes. Dr. S. Sasidharan, Head, Department of Hindi, Cochin University of Science and Technology was the Chief Guest of the valedictory function. Winners of competitions and overall contributors for the year were felicitated during the function.

A view of Drama ' Bhaichaara' staged of Hindi addressing the staff

Hindi Day/ week/ Fortnight : Observed in all Regional and Research Centres of CMFRI.

National Official Language Seminar

A National Official Language Seminar on the subject 'Biodiversity' was conducted on 10.10.2011 at CMFRI, Cochin. The seminar was inaugurated by Dr. N. Mohanan, Professor, Department of Hindi, Cochin University of Science and Technology, Cochin.

Publications

- MFIS - Issue Nos. 205 & 206
- CMFRI Newsletter Cadalmin - Issue Nos. 128, 129, 130&131
- Special publication on Biodiversity
- Annual Report 2010-2011 with Hindi Executive summary

Release of Special publication on Biodiversity on the occasion of National Seminar held on 10.10.2011 by the Chief Guest

Dr. Prasannakumar Patsani, Convenor of the IInd Sub Committee of Parliament released the Fisheries Glossary on 20.10.2011

- Pamphlet on Cobia culture
- Pamphlet on Green Algal extract
- Fisheries Glossary English - Hindi
- Institute Telephone Directory

E-governance programmes continued

(i) Web display of Tender Notice / Advertisement of Posts
(ii) Use of bilingual software for fishing data collection
(iii) Digital display of Institute's Hindi publication
(iv) The Terminology Bank of Institute's Fisheries Glossary made available at Internet.

Awards

Mangalore Research Centre

Mangalore Research Centre bagged Consolation prize for the best Hindi implementation activities under the category of Central Govt. Offices under Mangalore Town Official Language Implementation Committee. Dr. Prathibha Rohit, Sr. Scientist and Shri Subrahmania Bhat, Technical Officer attended the meeting on 15th June, 2011.

CMFRI bagged Indira Gandhi Rajbhasha Puraskar

CMFRI bagged Indira Gandhi Rajbhasha Shield for the excellent Hindi implementation activities under the category Boards / Autonomous Bodies / Societies etc. in Region 'C' for the year 2009-2010. On the occasion of Hindi Day on 14.09.2011 the Hon'ble President of India Smt. Prathibha Devi Singh Patil awarded the Puraskar in the programme organized at Vigyan Bhavan, New Delhi. Shri P. Chidambaram, Minister of Home Affairs presided over the function. Shri Mullappilli Ramachandran and Shri Jitendra Singh, Ministers of State for Home Affairs graced the occasion. Smt. Veena Upadhyay, Secretary, Department of Official Language extended vote of thanks. On behalf of the Institute Smt. Sheela P.J., Assistant Director (OL) received the award.

Hon'ble President of India Smt. Prathibha Devi Singh Patil presenting Indira Gandhi Rajbhasha Puraskar

Participation of Scientists in Conferences / Meetings/ Workshops/ Symposia/ Trainings etc.

Dr. G. Syda Rao, Director

- Attended the 220th Governing Body Meeting of ICAR 6th April 2011
- Attended the First Meeting of the TaskForce for Conservation on Marine Biodiversity in the Society of Integrated Coastal Management at New Delhi on 8th April 2011
- Attended the First Meeting of the Working Group on Development and Management of Fisheries and Aquaculture for the Twelfth Five Year Plan (2012-17) held at National Fisheries Development Board (NFDB) at Hyderabad on 16th April 2011
- Participated in the Parliamentary Committee Inspection and visited Mandapam Regional Centre of CMFRI on 9th May 2011
- Participated in the Workshop on" Diversification of Species in Aquaculture: Status and potential" on the occasion of Golden Jubilee Celebration of C.I.F.E., Mumbai on 19th May 2011
- Visited Visakhapatnam Regional Centre of CMFRI and attended the inaugural function of Mariculture Laboratory and office building on 9th June 2011
- Attended the 8th meeting of the Technical Monitoring Committee (TMC) for the Central Sector Scheme on "Strengthening of Database and Geographical Information System for the Fisheries Sector" held at Shillong on 3rd June 2011
- Attended the Governing Body Meeting of ICAR on 4th July 2011
- Attended the Directors' Conference on 15th July 2011
- Attended the 83rd ICAR Foundation Day and Award ceremony of DAC & ICAR on 16th July 2011
- Attended the Sub-group meeting of DARE on 17th July 2011
- Attended the Second meeting of the Working Group on the Development and Management of Fisheries and Aquaculture for XIIth Five Year Plan at CIFRI, Barrackpore on 22th July 2011
- Visited Space Application Centre and had discussion with the Director of Space Application Centre and the Scientists of Marine Research Wing on 9th August 2011
- Attended the Brain storming session on certification and Eco labeling in Fisheries at NASC, New Delhi on 27th August 2011
- Visited Vizhinjam Research Centre of CMFRI to participate in the Foundation stone laying ceremony along with DG and DDG (Fy), ICAR during 2nd - 3rd September 2011
- Attended the Governing Body Meeting of ICAR on 4th October 2011
- Participated in the Workshop on the Joint project proposal "Preparing for Climate Change on Marine Systems in Australia and India" under AISRF at Hobart, Tasmania from 12th to 16th January 2012
- Attended the Governing Body meeting of ICAR on 4th Febuary 2012
- Attended the Directors-Vice Chancellors Interface and Directors' Conference at NASC Complex, New Delhi during 17th -18th Febuary 2012

Scientists

APRIL, 2011

- The Transboundary Diagnostic Analysis (TDA) consultation workshop organized by FSI on 7th April 2011 - **Dr. G Maheswarudu, Dr. P. Laxmilatha, Dr. Shubhadeep Ghosh, Mr. Loveson Edward**
- Workshop on "Cobia and other marine finfish farming" held at Fisheries College and Research Institute, Thoothukudi on 11th April 2011 - **Dr. G. Gopakumar, Dr. A.K. Abdul Nazar, Dr. G. Tamilmani, M. Sakthivel, C. Kalidas, P. Ramesh Kumar**
- USFDA Training on Aquaculture Food Safety Prevention Program, India at Chennai during 19th - 20th April, 2011 - **Dr. Joe K. Kizhakudan**
- District level fishermen interaction meeting at MSSRF, Thangatchimadam on 19th April 2011- **Dr. B. Johnson**
- National Consultation on Ecosystem Indicators in BOBLME at Hotel Harbour View Residency, Atlantis, M.G. Road, Kochi during 26th - 27th April 2011 - **Dr.V. Kripa, Dr. P. U Zacharia**

MAY, 2011

- 4th CAC meeting of the NAIP project on "Bioprospecting of genes and allele mining for abiotic stress tolerance" at New Delhi from 2nd to 4th May 2011 - **Dr. K.K. Vijayan**
- 22nd NACA Governing Council meeting held at Ramada Hotel, Cochin during 9gth - 11th May 2011 - **Dr. E.V. Radhakrishnan and Dr. Josileen Jose**

- NACA/CMFRI Seminar Emerging issues in Asian Aquaculture at CMFRI, Kochi on 12th May 2011 - **all scientists**
- A short course on "Statistical Methods in Ecotoxicology using R" conducted as a part of SETAC Europe 21st Annual Meeting, Milano Convention Centre, Milan, Italy during 15th - 19th May 2011 - **Dr. Sandhya Sukumaran**
- National workshop on shrimp BMP program at CIBA, Chennai organized by CIBA/ASEM/MPEDA/NACA from 16th to 18th May, 2011 - **Dr. R. Geetha**
- Meeting in Ballast water project organized by Director General, Shipping Corporation of India Limited at Jahaz Bhavan, Mumbai on18th May 2011 - **Dr.V.V. Singh**
- Mini symposium on Aquaculture organized by Central Institute of Fisheries Education, Mumbai on 19th May 2011 - **Dr.V.V. Singh, Ms. Anulekshmi Chellappan**
- Mini Symposium on Aquatic Biodiversity organized by Central Institute of Fisheries Education, Mumabi on 20th May 2011 - **Dr.V.V. Singh**
- Served as members of the Expert Committee for the preparation of the Master plan for the Kerala University of Fisheries and Ocean Studies (KUFOS) at Govt. Guest House, Ernakulam on 23rd May 2011 - **Dr. K.K. Vijayan, Dr. K.S. Mohamed**
- 'ICAR – CII Industry Meet- 2011' held at NAAS Complex, New Delhi on 23rd May, 2011 - **Dr.V.P.Vipinkumar**
- Working group meeting of the Sub group I- Marine Fisheries (Including mariculture and brackishwater aquaculture), for 12th five year plan organized by CMFRI and Planning commission of India on 24th May, 2011 - **Dr. R. Narayana Kumar, Dr. Imelda Joseph, Dr. Shoji Joseph, Dr. Boby Ignatius**
- Expert team to undertake survey of Lakshadweep Island along with NFDB officials during 24th - 27th May 2011 - **Dr. E.V. Radhakrishnan**
- Workshop on preparation of Technology Road Map for Kerala on "Aquaculture Fisheries and Livestock Sector" at Sasthra Bhavan, Pattom on 25th May 2011 - **Dr. Rani Mary George**
- Fisheries Stake holders District Validation Workshop for 2 districts (Chennai and Thiruvallur) organized by Government of Tamil Nadu and FAO under the project "Fishries Management for Sustainable Livelihoods" (FIMSUL) at Royapuram, Chennai on 25th May 2011 - **Dr. R. Geetha**
- Delivered a Lecture "Status report on hard coral biodiversity, threats and Conservation" for CIFE Golden Jubilee Mini Symposium series – Aquatic Productivity organized by Fisheries Resources Division on 30th May 2011 - **Dr. Rani Mary George**
- Attended the launching of SIBER project "Flow of Matter through Trophic levels and Bio-Geo Chemical Cycles in Marine and Estuarine Ecosystems" at Mangalore RC of CMFRI and inaugurated the workshop on 30th May 2011 - **Dr. P.U Zacharia.**
- Passive integrated transponder (PIT) tag training at RC of CMFRI, Mandapam from 30th May to 2nd June 2011 - **Shri. Ritesh Ranjan and Mr. Loveson Edward**

JUNE, 2011

- WWF Workshop on Shrimp Fisheries Management Plan South West Region, India, at Avenue Centre, Panampilly Nagar, Kochi during 1st - 2nd June, 2011- **Dr. G. Maheswarudu, Dr. P.U Zacharia, Dr. Josileen Jose, Dr. T. M. Najmudeen**
- Delivered a lecture on "Ecosystem health with special reference to fish health management issues in Indian Aquaculture scene" at the Golden Jubilee Seminar organized by CIFE, Mumbai on 2nd June 2011 - **Dr. K.K. Vijayan**
- Eighth Technical Monitoring Committee Meeting of DADF project on "Strengthening database and GIS for the fisheries sector" held in Shillong, Meghalaya on 3rd June, 2011 - **Dr.T.V. Sathianandan, Dr. J. Jayasankar**
- Golden Jubilee function of Central Institute of Fisheries Education, Mumbai on 6th June 2011 - **Dr.V.V. Singh**
- First South Asia Sub-Regional Workshop of UNEP/CMS Dugong MOU at Tuticorin during 6th - 7th June 2011 - **Dr. E.Vivekanandan**
- One-day workshop for all project associates of MOES funded SIBER project at Manglore RC of CMFRI on 7th June 2011 - **Dr. Sujitha Thomas**
- Panel Member in the XI review meeting of Analytical Chemistry Division of Bhabha Atomic Research Centre, Trombay on 7th June 2011 - **Dr.V.V. Singh**
- QRT for network project on Climate change and made presentations on the progress of work under the project on Climate change at the University of Agricultural Sciences, Hebbal, Bangalore during 13th -15th June 2011 - **Dr. E.Vivekanandan**
- Meeting-cum-workshop on "Towards more effective role of Heads of Divisions and Regional Stations in ICAR Institutes" held at Central Institute of Agricultural Engineering, Bhopal during 14th - 15th June 2011 - **All Heads of Divisions and Scientists - in - Charge of Regional and Research centres of CMFRI**
- Meeting held at Centre for Social Action (CSA), Goreagon to discuss repercussions and damage in connection with the water pollution on fisheries of Maharashtra on 20th June 2011 - **Dr. V. D. Deshmukh**

- Meeting with officials of Centre for Social Action, Mumbai regarding MMPL consultancy project on 20th June 2011 - **Dr. V.V. Singh**
- Attended the meeting organized by the Commissioner of Fisheries, Govt. of Andhra Pradesh in the Secretariat, Hyderabad for discussing the damage caused to marine fisheries due to pollution along the Andhra Coast on 21st June 2011 - **Dr. G. Maheswarudu**
- Meeting of the Academic council of TANUVAS at Madaras Veterinary college, Chennai on 22nd June 2011 - **Dr. K.S. Mohamed**
- Seminar on "Integrated Development of Coastal Area" organized by 'Jeevana' and CADAL, at Calicut on 23rd June 2011 - **Shri K.P. Said Koya**

JULY, 2011

- Planning Commission Group VIII meeting on Agricultural Extension in difficult areas at TANUVAS, Chennai. on 1st July 2011- **Dr. E. Vivekanandan**
- Served as member of the Project Monitoring and Review Committee of the Open Sea Mussel farming project funded by NABARD for the Mussel Farmers of Kasargode District held at the project site at Kasaragod on 4th July 2011 - **Dr. V. Kripa.**
- Workshop cum brainstorming session on Forecasting technological needs for fishing and fish processing sector in India jointly organized by CIFT, Kochi and IASRI, New Delhi on 7th July 2011 - **Dr. P.U Zacharia. Dr. V.P. Vipin Kumar, Dr. Shyam S Salim, Dr. N. Aswathy**
- Workshop on "Marine Fisheries in India" organized by Department of Animal Husbandry Dairying & Fisheries in collaboration with World Bank at World Bank, Lodhi Estate, New Delhi on 7th July 2011 - **Dr. T.V. Sathianandan, Dr. R. Narayana Kumar**
- State level KVK Interface Meeting in Kerala and Lakshadweep at KAU, Mannuthy, Thrissur on 7th July 2011 - **Dr. P. Kaladharan**
- Consultative Brain storming workshop on 'Vision Document and strategic Plan conducted by Kerala University of Fisheries & Ocean Studies, Panangad, Kochi during 8th - 9th July 2011 - **Dr. E.V. Radhakrishnan**
- MMPL project meeting with fishers held at Madh/Bhati, Mumbai on 12th July 2011 - **Dr. V.V. Singh**
- Stakeholders Meet at Project Management Unit of IFAD assisted "Post Tsunami Rehabilitation Programme" of Tamil Nadu Corporation for Development of Women Ltd. on 12th July 2011 - **Dr. Shoba Joe Kizhakudan**
- Training on Application of UNICODE at Central Institute of Fisheries Education on 13th July 2011 - **Ms. Anulekshmi Chellappan**
- First pilot workshop on Asian Cities Adapt – Impact of Climate Change in Target Cities in India and Philippines and Local Adaptation Strategies Project organized by the Cochin Corporation at Hotel Avenue Regent, Cochin on 13th July 2011 - **Dr. V. Kripa**
- Inauguration of Ocean State Forecast and Fishery Information System for Kerala organized by Centre for Earth Science Studies (CESS) at Vizhinjam on 16th July, 2011 - **Dr. Rani Mary George, Dr. S. Jasmine**
- TOLIC meeting of Veraval conducted at LIC Office, Veraval on 16th July, 2011-**Dr. R. Thangavelu, Sri. Sreenath K.R.**
- Workshop on 'Reproductive dynamics and stock assessment of crustaceans' organized by the Crustacean Fisheries Division, CMFRI, Kochi during 18th - 23rd July 2011 - **All scientists of Crustacean Fisheries Division**
- Sixth scientific advisory committee meeting held at the KVK of Karnataka Veterinary Animal and Fisheries Sciences University, Mangalore on 19th July 2011 - **Dr. P. S. Swathi lekshmi, Dr. G.B. Purushottamma**
- Delivered a talk on "Developing Management Systems in Capture Fisheries" to international trainees in BOBP-IGO organized training programme on Code of Conduct for Responsible Fisheries at Chennai, on 21st July, 2011- **Dr. E. Vivekanandan**
- Convened m-KRISHI® Mobile Service launching at Sagunabag, Neral under NAIP component-3 sub-project (World bank- GEF) on 22nd July 2011 - **Dr. V.V. Singh**
- Meeting with fishers regarding MMPL project work to be held in Madh village on 25th July 2011- **Dr. V.V. Singh**
- Workshop on Stock assessment of tuna for consolidating the data collected under the project PEL/IDP/03: strategies for sustaining tuna fishery along the coast on India at CMFRI Cochin from 25th to 30th July 2011 - **All scientists of Pelagic Fisheries Division**
- Meeting with local fishermen regarding MMPL project work to be held in Gorai and Manori village on 27th July 2011- **Dr. V.V. Singh**

AUGUST, 2011

- MDP on Data mining and GIS for Decision support in Agriculture at Indian Institute of Management (IIM) Lucknow during 1st - 12th August 2011 - **Dr. T.M Najmudeen**.
- TUFFS project meeting at CMFRI Cochin on 1st August 2011 - **Dr. Shubhadeep Ghosh, Sri Loveson Edward**
- FSI-CIFNET-CIFT-ICG Interactive Training Workshop on Pelagic and Midwater Trawling at CIFNET, Visakhapatnam on 1st August 2011 - **Dr. P. Laxmilatha, Smt. Muktha M.**

- Participated and delivered talk on 'Marine conservation and livelihood issues' in policy Seminar organized by DHAN foundation at Ramanathapuram, Tamil Nadu on 2nd August 2011 - **Dr. G. Gopakumar, B. Johnson**
- Participated in meeting with local fishermen regarding MMPL project work held in Erangal Bhati village on 5th August 2011 - **Dr. V.V. Singh**
- National Consultation on Gender Perspective in Agriculture meeting at New Delhi from 7th to 8th August 2011 - **Dr. V. Kripa.**
- Training on Plankton and Benthos at Vizhinjam Research centre of CMFRI, during 8th - 12th August, 2011 - **Shri. Saravanan**
- Training programme on data analysis using SAS at University of Agricultural Sciences, Bangalore from 8th to 13th August, 2011 - **Dr. R.Geetha**
- NARAKAS meeting at Central Institute of Fisheries Education on 9th August 2011 - **Ms. Anulekshmi Chellappan**
- Participated as a member of the state local technical group at KILA, Mulamkunathukavu, Trichur, organized by the Director, Kerala Institute of Local administration, Trichur on 12th August 2011 - **Dr. K.S.Mohamed**
- 4th meeting of Farmers First Committee organized by Central Institute of Freshwater Aquaculture at Vijayawada on 13th August 2011 - **Dr. G Maheswarudu, Dr. Joe K. Kizhakudan**
- Workshop on biodiversity valuation of marine ecosystem of the southwest coast of India during 16th - 18th August, 2011 and 27th to 30th December, 2011 - **Dr. S. Jasmine , Shri. Saravanan**
- Third meeting of the Working Group on the Development and Management of Fisheries and Aquaculture for the 12th Five Year Plan (2012-2017) for preparation of project proposals under capture fisheries and mariculture at CIBA, Chennai on 18th August 2011 - **Dr. E.Vivekanandan, Dr. Boby Igantius**
- DBT 4th Task Force Meeting on Aquaculture and Marine Biotechnology at CIFE, Mumbai during 19th - 20th August 2011 - **Dr. K.K.Vijayan**
- Hindi Workshop held at Madras RC of CMFRI, Chennai on 20th August 2011 - **Dr. E.Vivekanandan**
- 7th Kerala Environment Congress at Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram from 25th to 27th August 2011 - **Dr. Rani Mary George, Dr. S. Jasmine**
- Dr. S. Jones Centenary Colloquium on 'Challenges in Marine Mammal Conservation and Research in the Indian Ocean (CIMCAR)' organised by MBAI at CMFRI., Kochi during 26th - 27th August 2011 - **All scientists CMFRI**
- NAIP subproject review meeting held at Alibaug 27th August 2011 - **Dr. V. V. Singh**
- Participated in JNPP project meeting at NPCIL, Turbhe, Navi Mumbai on 30th August 2011 - **Dr. V.V. Singh**
- Inaugural meeting on Marine Finfish Stock Enhancement Program organized by Rajiv Gandhi Centre for Aquaculture at Vizhinjam on 31st August 2011 - **Dr. Rani Mary George**

SEPTEMBER, 2011

- Meeting of RFD Nodal Officers of Fisheries Research Institutes at Fisheries Division (ICAR) on 1st September 2011 - **R. Narayanakumar**
- Participated in Institute Management Committee (IMC) meeting at NBFGR, Lucknow on 3rd September 2011 - **Dr. V. V. Singh**
- First Bi-National Stakeholder Consultlation on Sustaining the Gulf of Mannar Ecosystem and its Resources, organized by Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO) along with the Bay of Bengal Large Marine Ecosystem (BOBLME) project at Rameswaram during 5th - 6th September, 2011 - **Dr. E.Vivekanandan, Dr. G. Gopakumar, Dr. K. Vinod, Dr. B. Johnson**
- Department of Science & Technology, Govt. of India Sponsored programme on "Science Administration and Research Management" from 5th and 16th September 2011, at ASCI, Hyderabad. **Dr. K.K. Vijayan, Dr. Imelda Joseph**
- Awareness campaign on FAO's Code of Conduct for Responsible Fisheries held at Mangalore Bundur Jetty, New Wharf, Mangalore, College of Fisheries, Mangalore. on 8th September 2011 - **Dr. P. S. Swathi lekshmi**
- National Consultative workshop for the preparation of vision document and strategic plan of Kerala University of Fisheries and Ocean Studies, Cochin during 11th - 12th September 2011 - **Dr. Shyam S Salaim**
- Phone-in programme organized by MSSRF on 12th September 2011 - **Dr. B. Johnson**
- Mid-Term review and Stakeholders Meet at Project Management Unit of IFAD assisted "Post Tsunami Rehabilitation Programme" of Tamil Nadu Corporation for Development of Women Ltd. on 13th September 2011 - **Dr. R.Geetha, Dr. Shoba Joe Kizhakudan**
- Workshop on Techniques and methodologies in fishery biology on finfishes and shellfishes under NICRA project at Mangalore RC of CMFRI from 15th to 17th September 2011 - **Dr. Jayasree Loka, Dr. Divu Damodaran, Ms. Anulekshmi Chellappan**

- m-KRISHI® Fisheries Mobile Service launching at Alibag, Raigad under NAIP component-3 sub-project (World bank- GEF) on 16th September 2011 - **Dr.V.V. Singh**
- National seminar on 'Technology for women empowerment: issues and challenges' held at Cochin University of Science and Technology, Kochi during the period from 16th to 17th September, 2011 - **Dr. V. P. Vipinkumar**
- Scientific Advisory committee –Marine Living Resources Programme at CMLRE, Kochi during 16th - 17th September, 2011 - **Dr. K.S.Mohamed**
- International coastal cleaning day organized by MSSRP & NETFISH on 17th September 2011 - **Dr. B. Johnson**
- Program for the Stakeholder Consultation on Climate Change Platform at CRIDA Hyderabad from 19th - 20th September 2011 - **Dr. G. Gopakumar, Dr. Shubhadeep Ghosh**
- Attended the MoEF meeting and made the Final presentation of the Report of the Consultancy Project - 'Marine EIA study for Kudankulam Nuclear Power Plant at MoEF, New Delhi from19th to 21st September 2011 - **Dr. V. Kripa.**
- Delivered a lecture on "Status of marine fisheries and its impact on marine environment", at Gogate College, organized by Kirloskar Vasuudhara at Ratnagiri on 25. from19th to 21st September 2011 - **Dr.V. D. Deshmukh**
- Hindi workshop "Rules and Articles concerned with official language implementation" organised at Karwar RC of CMFRI on 26 from 19th to 21st September 2011 - **Dr. Divu Damodaran**
- IMC meeting at CIFA, Bhubaneswar on 22nd September 2011 - **Dr. V. Kripa**
- Served as chair and delivered keynote address at the national seminar on modern streams of biochemistry on the topic "Food safety and contamination issues" St. Albert's College, Cochin 22nd September, 2011- **Dr. K.K. Vijayan**
- Attended the Mid-Term Review Meeting of Action Taken Report of XX Meeting of ICAR Regional Committee-II at CIFRI, Barrackpore, Kolkata on 24th September 2011 - **Dr. G Maheswarudu**
- IMC meeting at ICAR Research Complex for Goa as member on 27th September 2011 - **Dr.V. Kripa.**
- Attended e-publishing training organized by ICAR & CMFRI at Kochi on 27th September 2011 - **Dr. Rani Mary George, Dr. K.S. Sobhana, Dr. K. Vinod, Dr. B. Santhosh, Dr.T. M. Najmudeen, Dr. Jayasree Loka, Dr. R. Jayakumar**
- Participated and presented paper in the National Seminar organized by Indian Society of Extension Education (ISEE) at Jawaharlal Krishi Vishwa Vidyalaya, Jabalpur (M.P.) on 27th to 29th September 2011- **Dr. B. Johnson**
- National official language seminar on Biodiversity, 29th September 2011 - **Shri. Saravanan**

OCTOBER, 2011

- TUFFS (Tuna Tagging Project) Inception Workshop, organised by INCOIS at Hotel Daspalla, Visakhapatnam on 1st October 2011 - **Dr. Shubhadeep Ghosh**
- NAIP Consortium meeting at Fisheries College and Research Institute, Tuticorin on 3rd October 2011 - **Dr. G.Gopakumar**
- Meeting on the 12th Plan for the Fisheries Sector of Kerala State as a Working Group Member at Director of Fisheries, Vikas Bhavan, Traivandrum on 4th October 2011 - **Dr.V. Kripa, Dr. K.S. Mohamed**
- Undertaken sea cruise for validation of m-KRISHI® Fisheries Mobile Service on 5th October 2011 - **Dr.V.V. Singh**
- Hindi National seminar on Biodiversity at Kochi for presentation regarding the work done under consultancy project on 10th October 2011 and won best presentation award for the same **-Dr.V.V. Singh**
- Invited as Chief Guest in the short term training program arranged by Taraporevala Marine Biological Research Station, Mumbai on 'Freshwater Ornamental Fish Breeding, production and management' and delivered lecture on the related topic on 11th October 2011 - **Dr.V.V. Singh**
- Delivered a lecture at Nuclear Powar Corporation Ltd. Nabhikiya Urja Bhavan, Anushaktinagar regarding consultancy project of Jaitapur Nuclear Power Park (JNPP) on 11th October 2011- **Dr.V. D. Deshmukh**
- Meeting at the Fisheries Office at Kadungalloor, Aluva, Ernakulam District on 11th and 20th October 2011 - **Dr.V. Kripa.**
- Participated in stakeholders consultation organized by MSSRF on 12th October 2011 - **Dr. B. Johnson**
- Ballast water committee meeting at DG Shipping office, Ballard Pier, Mumbai on 13th October 2011 - **Dr. V. V. Singh**
- Delivered a lecture on "Economic analysis of aquaculture production system" during the Training programme on aquaculture organized by Navabharat Foundation and Central Marine Fisheries Research Institute, Cochin on 14th October 2011 - **Dr. Shyam.S.Salim**
- Convened meeting of fishers with Department Fisheries officials, Maharashtra state and with Assistant

Commissioner, MCGM held at Bhati under MMPL project on 18th October 2011- **Dr.V.V. Singh**

- National consultation on "Water: Research Prioritization" held at NBFGR, Lucknow on 18th October 2011 - **Dr. Imelda Joseph, Dr. U.Ganga**
- Participated in the panel discussion with the primary stakeholders and scientist on during the training programme on aquaculture organized by Navabharat Foundation and Central Marine Fisheries Research Institute, Cochin on 19th October 2011-**Shyam. S. Salim**
- Attended meeting at Coastal Aquaculture Authority regarding the National Conference of State Fisheries Ministers on 19th October 2011 - **Dr.A.Margaret Muthu Rathinam**
- Delivered a lecture to fishers on shrimp resources at Central Institute of Fisheries Education, Versova, Mumbai on 20th and 21th October 2011 - **Dr. V. D. Deshmukh**
- Participated in the short term training course on 'Code of conduct for responsible fisheries and sea safety' organized by CIFE, Mumbai as a resource person for delivering lecture on related topic from 20th to 21st October 2011 - **Dr.V.V. Singh**
- Participated in the Review meeting of Open Sea Mussel farming at Padanna under Rural Innovation Fund from NABARD, Kasaragod during 20th - 22nd October 2011. - **Dr. K. S. Mohamed**
- Attended the Project Monitoring & Review Committee (PMRC) Meeting at Padanna, Kasaragod on 21st October 2011 - **Dr.V. Kripa**
- Entrepreneurs Meet on "Development Scene in Fishery Waste Utilization" at VRC of CIFT, Visakhapatnam on 21st October 2011 - **Dr. G Maheswarudu**
- Meeting for presentation of the proposal on "Platform for Diagnostics and Vaccines" at IVRI from 28th to 29th October 2011 - **Dr. K.K. Vijayan, Dr. M.A. Pradeep**
- Training-cum-workshop under TUFFS Project at Visakhapatnam RC of CMFRI from 28th October to 2nd November 2011 - **Dr.V. Kripa, Dr. K.S. Mohamed**

NOVEMBER, 2011

- Participated in the Stakeholders Meet conducted by FIMSUL (FAO) for fishermen of Tamil Nadu and Puducherry at Mahabalipuram during 1st - 2nd November 2011 - **Dr. Shoba Joe Kizhakudan**
- Meeting on "Bioprospecting of genes and allele mining for abiotic stress tolerance" held at IARI, PUSA, New Delhi during 1st - 3rd November 2011 - **Dr. M.A. Pradeep**
- Brain Storming Session on Cell-lines Development organised by Department of Biotechnology at DBT, New Delhi on 4th November, 2011 - **Dr. K. S. Sobhana**
- 'Half yearly meeting of the Karwar TOLIC' at the conference hall of Syndicate bank regional office on 4th November 2011 - **Dr. Divu Damodaran**
- Attended the 'Zonal Workshop of ATIC' at Zonal Project Directorate, Hebbal, Bangalore and made the presentation of financial requirements and facilities required for ATIC of CMFRI during 4th - 5th November 2011 - **Dr. V.P.Vipinkumar**
- Participated and presented paper in the "International Conference on Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences" organized by International Society of Extension Education at NASC Complex, New Delhi during 9th - 12th November 2011 - **Dr. B. Johnson**
- Agricultur in the NASC Complex, New Delhi on 10th November 2011 - **Dr. V. Kripa**
- XII Plan meeting in Department of Fisheries, Govt. of Tamil Nadu held at the Secretariat, Chennai on 10th November 2011 - **Dr. E.Vivekanandan**
- Delivered a talk on "Impact of Climate Change on Marine Ecosystem and Fisheries "at the International Conference on "Impact of Climate change on Coastal ecosystem: ICC-ECO2011) at Sathyabama University, Chennai on 11th November 2011 - **Dr. E.Vivekanandan**
- Quinquennial review meeting of KVK activities and interaction with the scientists, officers, NGOs and farmers at the KVK, College of Fisheries, Mangalore, affiliated to the Karnataka Veterinary Animal and Fisheries Sciences University, Bidar on 13th November 2011 - **Dr. A.P. Dineshbabu, Dr. P.S. Swathi Lekshmi**
- Cluster level workshop as resource person to elicit current status and identify issues related to coastal and fisheries management conducted by IFAD Assisted Post Tsunami Sustainable Livelihood Programme (PTSLP) at Cuddalore on 14th November 2011 - **Dr. R. Geetha**
- First IOTC (Indian Ocean Tuna Commission) Working party meeting on Neritic Tunas" held at Chennai during 14th to 16th November 2011 - **Dr. Prathibha Rohit, Dr. M. Sivadas, K.P. Said Koya, Dr. E.M. Abdussamad**
- Meeting at the Director of Fisheries Office purchase of 45 units of FRP Boats and Out Board Motors for consultancy in Reservoirs and Rural Fisheries Demonstration tanks for 2011-2012 on 15th November 2011 - **Dr. A. Margaret Muthu Rathinam**
- Conference on 'Climate change: Oill Spill and Radiation Risk: New Environmental Challenges' organized by NEERI in association with BARC, MPCB, MCGM, BRNS,

MoEF, CPCB etc. and presented a paper on oil spill off Mumbai coast during 15th to 16th November 2011 - **Dr.V. D. Deshmukh, Dr. V.V. Singh**

- NABARD - Sensitization Programme on Scheme for Development/ Strengthening of Agricultural Marketing Infrastructure, Grading and Standardization" for Fisherfolk organized by the M.S. Swaminathan Research Foundation, Thangachimadam on 16th November 2011 - **Dr. K.Vinod**
- 6th State Level Co-ordination Committee meeting on Gulf of Mannar Biosphere Reserve Trust – Project Implementation at the Secretariat, Chennai, on 17th November 2011 - **Dr. Joe K. Kizhakudan**
- Summing up workshop on 'Literacy, Health and Income status of fishers' for the project funded by DAHD & F at CMFRI, Kochi on 17th to 18th November 2011- **Dr. R Sathiadhas, Dr R. Narayankumar, Dr. C. Ramachandran, Dr. V.P.Vipinkumar, Dr. Shyam S Salim, Dr. N.Aswathy, Dr. P.S. Swathilekshmi, Dr. B. Johnson, Dr. R. Geetha**
- Capacity building Wokshop on Bridging the Gap between Science and Management in The IOTC Process" held at Chennai during 17th to 18th November 2011 - **Dr. Prathibha Rohit, Dr. M. Sivadas, K.P. Said Koya, Dr. E.M. Abdussamad**
- Attended the 2nd meeting of the State Level Monitoring Committee organized by the Irrigation & CAD (PWD) Department, Government of Andhra Pradesh at Hyderabad on 18th November 2011 - **Dr. G Maheswarudu**
- International Conference-cum-exhibition 'Food 360' at Hyderabad International Convention Centre during 20th to 22nd November 2011 - **V.P. Dr. Vipinkumar**
- Attended a discussion at Calicut and presented a report on Research needs in Fisheries Sector organized by MICTRA, Calicut in connection with world fish workers day on 21st November 2012 - **Dr. P. Kaladharan**
- Discussion on the research needs in the fisheries sector organized by MICTRA, Kozhicode in connection with the World Fish Workers' Day on 21st November 2011 - **Dr. P. Kaladharan**
- Brainstorming workshop on Sustainable Management of ornamental fish resources of Kerala held during the occasion of the World Fisheries Day at Kerala University, Kariavttom, Trivandrum during 21st November 2011 - **Dr. Shyam S Salim**
- Eighth Symposium on Diseases in Asian Aquaculture organised by the Asian Fisheries Society at Mangalore during 21st to 25th November 2011 - **Dr. K.K. Vijayan, Dr. N.K. Sanil, Dr. Krupesh Sharma, S.N. Sethi, Dr. P.S. Swathilekshmi**
- Attended 4 district level meetings of purse seine committee at Ratnagiri, Malwan, Sassoon Dock and Palghar during 23rd to 24th November 2011 - **Dr. V. D. Deshmukh**
- Transboundary Diagnostic Analysis meeting of Bay of Bengal Large Marine Ecosystem at Chennai on 24th November 2011 and 29th December 2011 - **Dr. E.Vivekanandan**
- Meeting on Strategies for formulation of schemes for XII Plan period: Tamil Nadu State Fisheries Department on 26th November 2011 - **Dr. Joe K. Kizhakudan**
- Three days Interaction Meet of NARS Scientists trained through International Trainings in Frontier Areas of Agricultural Sciences (NAIP), at National Agriculture Science Centre, New Delhi during 28th to 30th November, 2011 - **Dr. K.S. Sobhana, Dr. Krupesh Sharma, Dr. Kajal Chakraborty**
- Workshop on stock assessment of tuna and preparation of scientific reports under the project PEL/IDP/03: strategies for sustaining tuna fishery along the coast on India at CMFRI, Cochin during 28th to 30th November 2011 - **All scientists of Pelagic Fisheries Division**
- Attended discussion session on necessity of Jaitapur Nuclear Power Plant at Dadar on 29th November 2011 - **Dr.V. D. Deshmukh**
- Participated in the CMU, CIC and National Director Review meetings of NAIP component III project 'Strategies to enhance adaptive capacity to climate change in vulnerable regions' and presented the progress of the project during 30th November to 3rd December 2011- **Dr.V.V. Singh**

DECEMBER, 2011

- "Bay of Bengal Large Marine Ecosystems(BOBLME) Project meeting of the working group on Indian Mackerel" at Kochi during 1st to 2nd December 2011 - **Dr. U. Ganga, Dr. E.M. Abdussamad**
- "BOBLME (Bay of Bengal Large Marine Ecosystem) workshop on assessing the data and assessment potential on Indian mackerel (*Rastrelliger Kanagurta*)" held at Kochi during 1st to 2nd December, 2011 - **Dr. T.V. Sathianandan, Dr. J. Jayasankar**
- Participated in the cruise on board 'Nasarulla' for resource assessment of Oceanic Squids at Agatti from 7th to 12th December 2011 and 17th and 24th January 2012 - **Shri K.P. Said Koya**
- "Dialogue on managing Karnataka's Fisheries" organized by Dakshin Foundation and College of Fisheries, Mangalore at the College of Fisheries, Mangalore during 8th to 10th December 2011 - **P. S. Swathi lekshmi**
- World Bank Mission Review of NAIP Component 3 project at Centre for Social Action, Alibag and

District Magistrate Office, Alibag in Raigad district of Maharashtra on 08.12.2011 and undergone desk review on for finalizing the roadmap 9th December 2011 - **Dr.V.V. Singh**

- High Level Committee meeting for the review of NICRA project including financial aspects, held at ICAR, New Delhi during 12th to 13th December 2011 - **Dr. E.Vivekanandan**
- Participated in the final workshop conducted by FIMSUL for finalization of the project report at Chennai during 12th to13th December 2011 - **Dr. Shoba Joe Kizhakudan**
- Nineth Indian Fisheries Forum held at Chennai during 19th to 23rd December 2011 - **All Scientists of CMFRI**
- International workshop on Fisheries Management for Sustainable Livelihoods (FIMSUL) of FAO on 20th December 2011 - **Dr. P.Kaladharan, DR. P. K.Asokan, Dr. P. P. Manojkumar, Shri K. P. Said Koya, Dr. Gulshad Mohamed**
- International Symposium on "Ecosystem Approach to fisheries in the Bay of Bengal Large Marine ecosystems" at Chennai on 21st December 2011 - **Dr. P. U Zacharia. Smt. T. S. Naomi, Dr. P. Kaladharan, Dr. P.K.Asokan, Dr. P. P. Manojkumar, Shri K. P. Said Koya, Dr. Gulshad Mohamed**
- DST-Lockheed Martin India Innovation Growth Program, 2012 at Chennai on 28th December 2011 - **Dr. Joe K. Kizhakudan**
- National workshop on Western Ghats and Coastal Biodiversity: Status, Threats and conservation strategies **Dr. K. K. Philipose**
- International seminar on ornamental fish organised at Kochi by the Government of Kerala in connection with the Aqua Show 2012 - **Dr. G. Gopakumar**

JANUARY, 2012

- Consortia Advisory Committee meeting and 2nd Workshop of NAIP component III projects at IARI, New Delhi during 5th to 8th January 2012 - **Dr.V.V. Singh**
- Hindi Vygyanic Sanghosti' held at NPCIL Kaiga on 10th January 2012 - **Dr. Divu Damodaran**
- International workshop on preparedness for Climate Change in Marine systems in India and Australia t Hobart, Australia sponsored by the ASIRF under the Department of Science and Technology, New Delhi - during 16th to 20th January 2012 - **Dr. G. Syda Rao, Dr. E.Vivekanandan, Dr. E.V. Radhakrishnan, Dr. C. Ramachandran, Dr. Shyam.S. Salim, Dr. T.V. Sathiandanan, Sr. Mukta Menon**
- Two days programme "Towards Excellence in Science" at Institute of Science and Delivered lecture on "Modeling populations and fish stock assessment" during 19th to 20th January 2012 - **Dr.V. D. Deshmukh**
- Refresher course on "Agricultural Research Management" at NAARM, Hyderabad during 19th January to 8th February, 2012 - **Dr. R. Jeyabaskaran**

FEBRUARY, 2012

- Sixth Task Force meeting on Aquaculture & Marine Biotechnology at Chennai during 6th to 7th February 2012 - **Dr. K.K.Vijayan**
- Brainstorming meeting to finalise the technical programmes of the statewise marine fisheries appraisal projects for the 12th Plan at CMFRI, Kochi on 6th February 2012-**All scientists of Capture Fisheries Divisions at Kochi**
- ASEM Aquaculture Platform WP7, international workshop on 'Empowering Vulnerable Stakeholder Groups' under the UPM (Universiti Putra Malaysia) organised in Felda Residence of Kuala Terengganu of Malaysia during the period during 6th to 10th February, 2012 - **Dr.Vipinkumar.V.P**
- Appointed as Vicechairman and member to study Purse seine fishery by Government of Maharashtra in the state and attended meeting of the high power committee constituted for the regulation of purse seine fishing in Maharashtra at Commissionerate of Fisheries, Mumbai on 7th February and on 6th March 2012 - **Dr.V. D. Deshmukh**
- Workshop on 'Fishery fluctuation in relation to Environment' at CMFRI, Kochi during 8th to 10th February 2012 - **All Scientists FEM Division**
- Advanced faculty training on "Development of brood and gene banks for aquaculture production and genetic conservation" at CIFE, Mumbai during 8th to 28th February 2012 - **Dr. Divu Damodaran**
- One day Sensitization Workshop on Half Yearly Progress Monitoring (HYPM) conducted at National Academy of Agricultural Research Manaement (NAARM), Hyderabad by Indian Agricultural Statistics Research Institute, New Delhi on 13th February 2012 - **Dr. R Narayanakumar**
- Training programme on Marine zooplankton at CMFRI, Kochi during 13th to 17th February 2012 - **All Scientists FEM Division**
- National Fund Workshop held at NAARM Hyderabad for understanding Consensus Building process for MMPL project. during 15th to 18th February 2012 - **Dr. V.V. Singh**
- Training programme on Marine finfish breeding and seed production technology at RC of CMFRI, Mandapam

during 15th to 24th February 2012 - **Dr. Jayasree Loka , Shri. Ritesh Ranjan**

- Meeting of the Academic council of TANUVAS at Madaras Veterinary college, Chennai on 20th February 2012 - **Dr. K.S. Mohamed**
- Meeting of RFD Nodal Officers of Fisheries Research Institutes organized by the Fisheries Division (ICAR) at Central Inland Fisheries Research Institute, Barrackpore, Kolkatta during 22nd to 23rd February 2012 - **Dr. R. Narayanakumar**
- TOLIC meeting of Veraval conducted at CIFT, Veraval on 23rd February, 2011 - **Shri K.R. Sreenath**
- National Conference on New Vistas in Inland Aquaculture in Commemoration of Silver jubilee Celebrations of CIBA, Chennai, during 23rd to 24th February, 2012 - **All Scientists and Technical staff of RC of CMFRI, Chennai**
- Attended Post Procurement Review by World Bank for NAIP Component-3 project 'Climate change Adaptation' at CIFE, Mumbai on 26th February 2012 - **Dr. V.V. Singh**
- National Seminar on 'Conservation of the marine environment and Management of marine fisheries' at Department of Zoology, N.S.S. College, Changanachery, Kottayam, Kerala on 27th February 2012 - **Dr. V. Kripa**.
- Served as IMC Member at Central Institute of Freshwater Aquaculture, Bhubaneswar on 29th February 2012 - **Dr. V. Kripa**
- Participated and organized the CMFRI stall in the International Trade Show "Aqua Aquaria India 2012 organized by MPEDA, Kochi at Chennai Trade Centre, Chennai during 29th February to 2nd March 2012 - **Dr. Joe K. Kizhakudan**

MARCH, 2012

- Product release of GMe at ICAR, New Delhi during 5th to 6th March 2012 - **Dr. K.K. Vijayan**
- Participated as a member in the 24th Institute Management Committee Meeting held at NBFGR, Lucknow on 6th March 2012 - **Dr. V.V. Singh**
- Australia-India Strategic Research Fund (AISRF) sponsored international workshop on "Preparing for climate change on marine ecosystems in India and Australia" at Kochi, India during 6th to10th March - **Dr. G. Syda Rao Dr. E.Vivekanandan, Dr. E.V. Radhakrishanan, Dr. P.U Zacharia, Dr. T.V. Sathianandhan, Dr. R. Narayanakumar, Dr. Prathiba Rohit, Dr. C. Ramachandran, Dr. Shyam. S. Salim, Dr. P.S. Swathilekshmi, Smt. Mukta Menon and Shri. Gyanaranjan Dash**
- Meeting organized by Centre for Social Action at St. Pias College, Goregaon for discussing the fisheries and environment related issues for MMPL project on 9th March 2012 - **Dr. V.V. Singh**
- Review meeting of technology up-gradation projects funded by NFDB held at NASC complex, New Delhi on 12th March 2012 - **Dr. Boby Ignatius**
- Training programme on "Advanced models on fish stock assessment and biodiversity analysis" in MRC OF CMFRI, Chennai during12th to 20th March, 2012 - **Dr. V. Venketesan, Dr. Sathya Narayana Sethi, Dr. K.S. Sobhana, Dr. T.M Najmudeen, Smt. Anulekshmi Chellappan, Smt. Mukta M., Smt. Hemasankari, Dr. Margaret M., Shri. K.R. Sreenath, Shri. Gyan Ranjan Dash, Smt. Swathy Priyanka Sen, Smt. Indira Divipala, Shri. Renjith, Shri. Ramkumar, Shri. Behera, Shri. Nayak**
- Attended and presented an invited paper in the "National Conference on Aquaculture: Fish for Billion" organized by CIFA, Bhubaneswar during 15th to 16th March 2012 - **Dr. K.K. Vijayan**
- Participated in consultancy group meeting held Fishery Survey of India, Mumbai on 19th March 2012 - **Dr. V.V. Singh**
- ICAR Network project workshop on climate change held at ICAR, New Delhi on 22nd and 23rd March 2012 - **Dr. E. Vivekanandan**
- Workshop on Indigenous Technical Knowledge (ITK) of fisher folk on climate change at Mangalore RC of CMFRI during 22nd to 24th March 2012 - **All NICRA Associates**
- National Seminar on "Indian Agriculture: Preparedness for Climate change" held at IARI, New Delhi as an invitee by the Indian Society of Agricultural Science, New Delhi. **Dr. E. Vivekanandan**

Deputation abroad

- Training in frontier areas of Agricultural Sciences on "Stem Cell Research" Stem Cell Research Centre, Rutgers, the State University of New Jersey, USA, under the HRD programme of NAIP (Component-1) during 1st April - 30th June 2011- **Dr. K.S. Sobhana**
- Nineth Asian Fisheries and Aquaculture Forum at Shanghai, China during 21st - 25th April, 2011 - **Dr. C. Ramachandran**
- BOBLME (FAO) Workshop on "Communicating Science Effectively – Scientific Paper Writing" held at Phuket, Thailand during 22th - 25th August 2011 - **Dr. E.Vivekanandan**
- Training course on 'Allele Mining (Fisheries)' at the Department of Animal Science, Iowa State University, Ames, Iowa, USA under the HRD programme of NAIP (Component-1) during 1st September to 30th November 2011 - **Dr. Srinivasa Raghavan.V**
- Seventh Regional Grouper Hatchery Production Training Course conducted by the Network of Aquaculture Centres in Asia-Pacific (NACA) at Situbondo & Bali Indonesia, during 25th September 2011 - 15th October 2011 - **Dr. A.K.Abdul Nazar, Shri. Ritesh Ranjan, Shri.C.Kalidas**
- Training course on Fisheries Governance at Wageningen International, The Netherlands under the Netherland Fellowship Programme during 26th September - 14th October, 2011 - **Dr. A. P. Dineshbabu**
- Training on 'Molecular Breeding' (Fisheries Sciences) at Institute of Aquaculture, University of Stirling, Stirling, U.K. under the HRD programme of NAIP (Component-1) during 1st October 2011 - 31st December 2011 - **Dr. M.Sakthivel**
- BOBLME (FAO) Workshop on "Communicating Science Effectively - Training on Scientific Presentation" held at Maldives during 11th - 14th October 2011 - **Dr. E.Vivekanandan**
- International Study Team Member to evaluate the support of FAO in the implementation of Code of Conduct of Responsible Fisheries to FAO headquarters at Rome and Ghana during 16th November - 4th December, 2011 - **Dr. C.Ramachandran**
- Twentieth Technical Advisory Board (TAB) meeting of the Marine Stewardship Council (MSC) at Berlin, Germany during 5th - 6th December, 2011 - **Dr. K.S. Mohamed**
- Workshop on "Preparing for climate change on marine systems in Australia and India" funded by Australia-India Strategic Fund (AISRF) for the period held at Hobart, Tasmania, Australia during 16th - 22nd January 2012 - **Dr. G. Syda Rao , Dr. E.Vivekanandan, Dr. E.V. Radhakrishnan, Dr. T.V. Sathianandan, Dr. C. Ramachandran, Dr. Shyam S. Salim Dr. Mukta Menon**
- ASEM Aquaculture Platform WP7, International Workshop on Empowering Vulnerable Stakeholder Groups' under the UPM (Universiti Putra Malaysia), Malaysia during 6th - 10th February, 2012 - **Dr. Vipinkumar. V. P.**
- International Study Team Member to evaluate the support of FAO in the implementation of Code of Conduct of Responsible Fisheries to Bengladesh, Thailand and Indonesia during February - March 2012 - **Dr. C. Ramachandran**

Green Algal extract (GAe)

Natural in every sense

A 100% vegetarian nutraceutical from nature for joint pain and arthritis

Green Algal extract (GAe) provides a unique blend of 100% natural, bioactive anti-inflammatory ingredient extracted from seaweeds with an ecofriendly "green" technology to combat joint pain and arthritic condition.

Concerted research effort by the scientists of CMFRI to explore new sources of secondary metabolites from seaweeds led to the design and development of GAe, a nutraceutical to combat inflammatory diseases (joint pain and arthritic conditions). Major components with antiinflammatory properties isolated from seaweeds have been used to formulate GAe. These are natural alternatives to synthetic anti-inflamatory drugs for combating arthritis.

The existing allopathic medications used in the treatment of joint pain and arthiritis, are reported to produce several undesirable side effects, expecially when used for longer duration. GAe is a green alternative to these allopathic preparations.

The active ingredients are chemically engineered to retain the anti-inflammatory properties for an extended shelf life and stability. Packed in low moisture content 'Naturecaps', Cadalmin™ GAe meet the needs of end users.

Each capsule contains: GAe active principle 500 mg.

Recommended dosage:

Two capsules a day after food for the first 3 months, followed by a maintenance dose of one capsule daily.

Contraindications

Pregnant or nursing women should consult a physician. People with seafood allergies should consult a physician before taking GAe.

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